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Robotic-Remote Operated Sensing Device for U.S. Coast Guard

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16. Abstract

This report describes a research program to evaluate if any state-of-the-art robotics technology is applicable to a hazardous-response robot for the Coast Guard. In general, little is known about the conditions facing a Coast Guard Strike Team when a chemical spill is initially encountered. This makes reconnaissance work both important and extremely hazardous. One way to reduce some of the risks facing the strike teams would be to first dispatch a reconnaissance robot to gather data and record images of the hazardous area. After the reconnaissance robot has completed its mission, the strike team would have images of the site and other relevant data to examine. Proper decisions with respect to safety and procedure will be easier for them to make when they are armed with data. The emphases of CMU's effort are to understand strike team procedures and to review state-of-the-art robotics technology. A conceptual design of a strike team reconnaissance robot will be synthesized from the available information.

The major goal of this project is to produce a conceptual design of a robotic system capable of reducing risks to the health and safety of strike team personnel. The project consists of three major objectives as outlined in the technical task directive:

- To collect information by surveying relevant published literature
- To visit manufacturers and users of robotic systems
- To prepare a final report of the results

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METRIC CONVERSION FACTORS

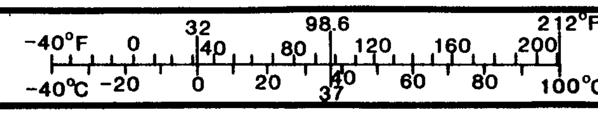
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (WEIGHT)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (EXACT)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly).

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (WEIGHT)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (EXACT)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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1. Executive Summary

Carnegie Mellon University (CMU) is conducting a research program for the Transportation Systems Center (TSC) and the United States Coast Guard to survey state-of-the-art robotics technology. The results of this study, together with the Coast Guard requirements, will be used to create the conceptual design of a reconnaissance robot that can be remotely deployed by Coast Guard hazardous response teams. This program has been funded through Omni Contract No. DTRS-57-93-D-00027 and is subcontracted to CMU through Battelle.

The research comprises three tasks: to collect information by surveying relevant published literature, to visit manufacturers and users of robotic systems, and to prepare a final report of the results and recommendations. CMU has conducted the literature search; visited the Atlantic Strike Team in Fort Dix, NJ and the Pittsburgh Marine Safety Office (MSO); talked to manufacturers and users of robotics; and met with a subset of the manufacturers.

The requirements of strike teams with respect to robotics technology are summarized in this document. The results of the literature search and a conceptual design of a hazardous-response robotic system are also included.

2. Introduction

Carnegie Mellon University (CMU) is conducting a research program for the Transportation Systems Center (TSC) to evaluate if any state-of-the-art robotics technology is applicable to a hazardous-response robot for the Coast Guard. This program has been funded through Omni Contract No. DTRS-57-93-D-00027 and is subcontracted to CMU through Battelle.

2.1. Background

Coast Guard strike teams travel to sites where chemical spills occur, and the teams begin the process of remediation of the area. The first task is to assess and characterize the problem. A reconnaissance team consisting of two people is dispatched to the spill area to gather data about the accident. In the most dangerous situations, they are required to use Level A protection which comprises an inner suit, a totally encapsulated outer suit, and a self-contained breathing apparatus. The command center is set up a safe distance away from the chemical spill, and this is where the team suits up for the mission. With a limited amount of air available (much of the air supply is exhausted as personnel travel between the command center and the accident site), team members are limited with respect to the time that they can spend at the site. Also, in most situations, little is known about the conditions facing the strike team. This makes reconnaissance work both important and extremely hazardous.

One way to reduce some of the risks facing the strike teams would be to first dispatch a reconnaissance robot to gather data and record images of the hazardous area. After the reconnaissance robot has completed its mission, the strike team would have images of the site and other relevant data to examine. Proper decisions with respect to safety and procedure will be easier for them to make when they are armed with data.

The emphases of CMU's effort are to understand strike team procedures and to review state-of-the-art robotics technology. A conceptual design of a strike team reconnaissance robot will be synthesized from the available information.

2.2. Objectives

The major goal of this project is to produce a conceptual design of a robotic system capable of reducing risks to the health and safety of strike team personnel. The project consists of three major objectives as outlined in the technical task directive:

- To collect information by surveying relevant published literature
- To visit manufacturers and users of robotic systems
- To prepare a final report of the results

In addition, the CMU team added the objective of meeting with strike teams to understand their requirements for robotics technology. This document outlines the activities undertaken to meet the project's objectives. CMU has conducted the literature search; visited the Atlantic Strike Team in Fort Dix, NJ, and the Pittsburgh Marine Safety Office (MSO); talked to manufacturers and users of robotics; and created a conceptual design of a strike team reconnaissance robot.

3. Results and Discussion

3.1. Strike Team Requirements

The Pittsburgh MSO and the Atlantic Strike Team were visited to gain an understanding of the needs and requirements of Coast Guard hazardous-response teams. The Coast Guard representatives at the Pittsburgh MSO gave a tour of a local barge transfer area at Aristech Chemical Corporation, located in Pittsburgh, PA. The Atlantic Strike Team is located at Fort Dix, NJ, and representatives of the CMU team toured the strike team's facility and discussed standard hazardous-response procedures with members of the team. This section will summarize the requirements of hazardous-response teams.

There are two modes of robotic site assessment:

- Routine warehouse, barge, and ship inspection
- Hazardous material spills in warehouses, barges, and ships

This report describes the requirements and design of a robotic system to perform reconnaissance missions in the event of hazardous chemical spills in warehouse, barge, and ship environments. Routine inspection of these environments is not under the charter of the strike teams and, as such, is not addressed explicitly in this document.

The Coast Guard representatives from the Pittsburgh MSO stated that about 50 percent of spill accidents occur in a warehouse environment; this number could not be confirmed with the Atlantic Strike Team because statistics were not available. However, the Atlantic Strike Team representatives agreed that a large number of their responses do occur in a warehouse environment. Also, they felt that the warehouse environment contained more unknowns than did barge and ship environments. Usually, the contents being shipped by barge and ship are known, and if a spill occurs, there is a short list of chemicals that might be encountered. In a warehouse, a large variety of items are stored, and before strike teams first enter the area to gather reconnaissance information, they often have difficulty in obtaining information on which chemicals are present. Because of the unknowns associated with warehouse chemical spills, they pose the most danger to the hazardous-response teams.

Warehouses are usually one level, but they may have an inclined ramp up to a mezzanine level. The aisles in this environment are wide, at least 4 feet in width; 55 gallon drums are stacked four or five high on skids in the aisles.

Most barge accidents occur with transfer hoses, when the cargo is transferred from a barge to a storage area on land. This means that, in most instances, a robot would have to be able to traverse the barge access platform to reach the chemical spill. A complicating factor is that there is a wide variety of barge access platforms. Immediate access to a barge may be via articulated stairs, lever ramps, or vertical ladders, and the minimum walkway width for access to barges is 23 inches. Navigation through this type of terrain is very difficult for robots.

Unfortunately, no ships were visited as part of this study because of logistics and budgetary reasons. From the visit with the Atlantic Strike Team, it was learned that access to the cargo hold might be from the deck of the ship. In other cases, robots might have to navigate through a ship's passageways, which are typically 42 inches in width (the minimum is 28 inches). In addition, the stairwells are open and inclined approximately 75°.

3.1.1. Levels of Protection

There are four levels of hazardous-response situations: Levels A, B, C, and D. The type of protective clothing required of strike team members is dictated by the level. The following is a listing of the protection required for each level:

- Level A - Inner suit, totally encapsulated outer suit, and a self-contained breathing apparatus (SCBA)
- Level B - Inner suit, outer suit, and SCBA
- Level C - Inner suit, outer suit, and an air purifying respirator (APR)
- Level D - Hard hats, safety glasses, and steel-toed boots

A reconnaissance robot would be particularly helpful in Level A and B situations. With an SCBA, a person has a limited supply of oxygen. The command center is normally set up a distance away from the problem, and much of the oxygen supply is exhausted in transit to and from the contaminated area, leaving little time for reconnaissance work at the site. A robot is not limited by the oxygen supply and thus could be very effective in gathering data from the hazardous site in Level A and B situations.

3.1.2. Zones of Exclusion

Three zones of exclusion are set up when a hazardous spill occurs: cold, warm, and hot. These are dependent upon terrain, weather, and the product which has been spilled. The general characteristics of the three zones of exclusion are defined in the following list:

- Cold zone - The zone furthest away from the chemical spill. This is where the command center is set up. In general, it covers the area approximately 100 to 150 feet away from the spill.
- Warm zone - The intermediate zone between the hot and cold zones. It covers the area approximately 50 to 100 feet away from the spill.
- Hot zone - The zone closest to the chemical spill. In general, it is approximately within 50 feet of the spill. This is where the appropriate level of protection is required.

Warehouse access is usually within either the warm or cold zones of exclusion while barge and ship accesses are usually within the warm zone. The strike team works in groups of two people. The first group is responsible for clearing a path to the source of the problem; often it does not

even get to the source. After a path has been cleared, the second group goes on a scouting or reconnaissance mission to the contaminated area, and its members take readings using three basic meters, which are discussed in more detail below. A third mission to the contaminated area requires the group members to take samples of the chemical spill. Once the situation is well understood, the process of cleaning the area can begin.

Thus far, this section has described strike team procedures and has outlined some background material. The remainder will focus on the requirements of a reconnaissance robot for hazardous-response situations.

3.1.3. Coast Guard System Requirements

As part of the first reconnaissance mission, the robot will be required to carry the following three meters into the hot zone of exclusion:

- Radiation meter - Detects the presence of radioactive materials.
- Multi-gas meter - Looks for oxygen deficiency, lower and upper explosive limits, and carbon monoxide presence.
- Photo-ionization detector or organic-vapor analyzer - Detects substance(s) which is (are) displacing the oxygen at the site.

Intense and directional lighting will be necessary to provide illumination for video pictures which the robot will acquire. Communication areas will be well shielded in both transmission and reception to prevent interference from ambient noise or other transmissions. Robot guidance will probably not be line-of-sight, so traditional teleoperation controls will be necessary.

The robot will be intrinsically-safe and explosion-proof, and it will meet the OSHA Class I Div. I requirements. Although nonsubmersible, it will be waterproof for decontamination procedures. The ideal maximum weight will be 150 pounds to enable the robot to be moved and handled by two people. This weight is a goal, and this requirement could be relaxed if necessary (e.g., if making the vehicle explosion-proof causes the weight to exceed the target). However, minimizing the weight of the vehicle to the extent possible is required. The robot will operate in a normal outdoor temperature range of -20° F to 130° F and in normal usage will not require an umbilical cable. Its power will be provided on board, and it will use wireless communications.

3.2. Literature Survey

One of the tasks undertaken as part of this project was to conduct a survey of relevant literature. A number of databases were reviewed for articles related to mobile robots and robotics technology. Most of the articles documented research that has been conducted in the field of robotics. In addition, literature from companies that build mobile robots was read to gain an understanding of the present state of commercial robotics technology. Thus, the spectrum of robotics technology from research to commercial options was examined in this survey. The following is a listing of the databases reviewed as part of this project:

- LIS - Contains bibliographic records for over 700,000 books, films, sound recordings, and other materials at Carnegie Mellon University's libraries.
- INSPEC ('88 - '94) - Contains bibliographic records with abstracts for over 5,600 scholarly publications in communications, computing, electrical engineering, electronics, physics, and information technology.
- Newspaper Abstracts - Contains bibliographic records with abstracts to articles from eight major national newspapers, including The New York Times, The Wall Street Journal, The Washington Post, The Christian Science Monitor, and others.
- Periodical Abstracts - Contains bibliographic records with abstracts to articles in over 1,000 general and scholarly journals and magazines in the areas of social sciences, arts, humanities, general sciences, and current affairs.
- ABI/INFORM - Contains bibliographic records with abstracts for over 750 periodical publications covering business, management, and company functions.

The databases were searched using relevant keywords as well as various combinations of the keywords. For example, some of the keys used were: robot, inspection, mobile, and hazardous. If these words appeared in the titles or abstracts of the papers, the articles would be selected by the system. The search of these databases initially produced abstracts of 235 articles related to this project. After the abstracts had been reviewed, it was determined that 58 of the articles warranted and therefore received further examination; a listing of these articles appears in Appendix A. In the remainder of this section, four areas will be explored: background information about robotic systems; mobile robot issues being researched; a hazardous-response robot, called the Hazbot, built by Jet Propulsion Laboratories; and a brief summary of the technology available from commercial manufacturers of robotics technology.

3.2.1. General Information about Robotics

A variety of mobile robots, including tracked, wheeled, and legged vehicles have been successfully built and tested. Many robots have been deployed in fields as diverse as the remediation of nuclear power plants and security operations. However, one must keep in mind that most mechanical implementations have been fairly simple and that many of these robots are driven remotely by an operator in a process known as teleoperation.

During the course of this study, it was learned that strike teams work in three distinctly different environments: warehouse, barge, and ship. Issues with respect to robot mobility in the warehouse environment have been solved to a large degree, and many commercial products are available for this environment. Because barge access areas and ships have tight passageways with many stairs, ladders, and obstacles, an intricate mobility device would be required to traverse these environments. Such devices are being researched, but at the present time, no commercial product is available that can meet the strike teams' needs with respect to mobility for barge and ship reconnaissance missions.

Control of a robot can range from completely teleoperated to autonomous. In the most primitive teleoperated systems, the operator possesses only low-level control of the robot. Low-level control refers to the initiation of a single action, such as the extension of a cylinder or a movement of a motor. If an operator only possesses low-level control of a robot, then an action which is composed of a sequence of low-level commands, such as a legged robot taking a step, could take a long time to complete. The solution is to add a level of control in which the robot performs a standard sequence of low-level commands with only one instruction from the operator. This dramatically improves the speed of the system, and most teleoperated systems use this principle. The navigation intelligence in standard teleoperated systems resides with the operator. Monitors at the control station display images from on-board video cameras, and operators use these images to help them to steer robots through their environments. More intelligence can be added to the robot, allowing for more autonomous motion; however, after a certain point, there is a penalty in response time. More processing is required for the system to interpret all of the sensory input and to "decide" what to do next. Thus, completely autonomous systems tend to move quite slowly. In a hazardous-response situation, time is critical, making standard teleoperation of more interest to the application examined in this report.

3.2.2. Mobile Robot Research

This section focuses on research with respect to the issue of mobility. Papers and reports which describe mechanical devices designed to climb stairs and ladders were of particular interest. No device examined in the literature search stood out as being ready for application to the problem of reconnaissance missions in barge access areas and ships. Some commercially-available robot platforms can climb stairs up to a 45° incline; however, the stairs in ships and barge access areas can be inclined as much as 75°, which is too steep for conventional robots to traverse. The devices that have been designed to climb steep stairs and ladders are still at early stages of development.

In general, research on the operation of robots in unstructured environments is only beginning [1]. Thus, while many people are exploring complicated mobility devices, the technology is not mature to the point where such devices are produced commercially. In "Study of an Intelligent Hexapod Walking Robot" [2], an intelligent hexapod walking robot is described. It was built to maneuver around a typical work environment which includes stairs and obstacles. The robot's dimensions are: 13.8 inches in length, 23.1 inches in width, between 14.6 and 29.9 inches in height (depending on whether the legs are extended), and 450 pounds in weight. It is not at a practical or commercial level, and although the robot is compact in size, its weight is a major liability [2]. Whether it could navigate the extreme inclines of stairs found on ships or in barge access areas is also doubtful, although no hard data was found to confirm this assumption.

The hexapod robot is typical of the state-of-the-art research in the area of mobile robots that can traverse complicated environments. It was included in this discussion to illustrate where research in the field is headed. Other devices of similar capabilities can be found in the articles listed in Appendix A.

3.2.3. Hazbot

The Hazbot is a hazardous-response vehicle being developed by the Jet Propulsion Laboratory (JPL) [3]. The initial objectives of the project were identifying and handling hazardous materials without putting people at risk. It has since been adapted for use in fighting fires [4]. The robot has been developed as part of JPL's Emergency Response Robotics Project.

The Hazbot is based on the Remotec Andros V mobile base, with modifications based on input from the JPL fire department; it is able to operate in combustible environments. The base is a tracked vehicle with articulated front and rear sections for traversing obstacles. Mounted on the base is a six degree-of-freedom manipulator that can perform a variety of tasks. An on-board computer controls the manipulator, track drives, and camera positioning and also processes data from the on-board sensors. Two video cameras provide visual information to the operator; one is located on the gripper while the second is on a movable pan-and-tilt platform. The operator workstation comprises two video monitors, a control panel to direct the robot's movement, and a monitor to display the sensor data and other system information. The following list outlines the technical data for the Hazbot:

- Six degree-of-freedom manipulator
  - 40-pound payload capacity
  - 30-pound grip force
  - Wrist-mounted camera
- Color video cameras
  - Mounted on the wrist and the mobile base
  - Pan and tilt features for the mobile base camera
- Mobile base
  - Remotec Andros Mark V-A
  - Articulated front and rear sections of tracks for traversing obstacles
  - Top speed of approximately 0.7 mph
- On-board batteries
  - 24-volt batteries provide power for all systems
  - Average mission life of approximately 3 hours
- Communication tether
  - 100-meter tether provides two-way communications for video and data
- Other
  - Sensors for oxygen, carbon dioxide, and combustible gases
  - Weight of approximately 600 pounds
  - Size of approximately 28 inches wide, 42 inches long, and 40 inches tall

– On-board 68030 VME-based computer

3.2.4. Commercial Robots

Many companies produce mobile robots commercially for a variety of tasks, including hazardous waste remediation and security. Commercially available robotics technology which could be employed as part of a reconnaissance robotic system for chemical spills in barge, ship, and warehouse environments was reviewed as part of this project. The products available from most companies were similar, and none of the robots completely met the strike teams' requirements.

Denning Mobile Robotics Inc. produces several robots; the most relevant to this project are the UTV-200 unmanned tow vehicle and the Sentry mobile security guard. The UTV-200 is a wheeled automated guided vehicle (AGV) which does not require floor tracks for guidance. The vehicle's dimensions are 36 inches by 30 inches by 48 inches, and it weighs 300 pounds. Its maximum speed is approximately 1.3 miles per hour, and its batteries can last up to 5 hours. Navigation through factory or office layouts is achieved via augmented dead reckoning using stored maps and a laser-based system to determine position and to sense for obstacles. The Sentry is a wheeled mobile vehicle which is designed for security operations. The vehicle's dimensions are a 29-inch diameter body by 48 inches in height, and it weighs 485 pounds. Its maximum speed is approximately 2 miles per hour, and its batteries can last up to 16 hours. The Sentry navigates via a programmed map and has a random-patrol option. The vehicle has 5 on-board computers, a miniature video camera, 24 ultrasonic detectors, infrared sensors to detect heat, and microwave sensors to detect motion.

Cybermotion Inc. produces the SR2, a wheeled mobile vehicle designed for security operations. The vehicle's dimensions are 34 inches in width by 76 inches in height, and it weighs 450 pounds. The maximum speed is approximately 1.7 miles per hour, and its batteries can last up to 15 hours. The SR2 navigates via a programmed map and uses ultrasonic sensors for navigation and collision avoidance; walls, halls, and other structural features are used for reference. The vehicle has an on-board video system, ultrasonic sensors, infrared sensors to detect heat, microwave sensors to detect motion, a smoke sensor, a temperature sensor, and a broad-spectrum gas sensor.

Remotec produces the Andros family of wheeled and tracked robots for hazardous situations. The Andros Mark V-A is a tracked mobile base which was used as part of the Hazbot [4]. Its tracks have articulated front and rear sections for traversing obstacles. The vehicle's dimensions are 28 inches in width by 41.5 inches in height by 31 inches in length (62 inches when the tracks are horizontal), and it weighs 550 pounds. The robot's maximum speed is approximately 0.9 miles per hour, and its power is supplied by two 12-volt batteries on board and one at the control station. Signal transmission is accomplished via a 328-foot cable with freewheel unwind and a manual rewind. Wireless and fiberoptic communication options are also available. The Andros Mark V-A has a standard manipulator with a load capacity of 35 pounds and a 66-inch reach. The robot has two low-light CCD cameras, one mounted on the arm and the second mounted on a pan-and-tilt mechanism located on the vehicle. The Mark V-A also has a variable intensity quartz-halogen light for each camera. The Mini-Andros is a smaller and lighter version of the Mark V-A. Its dimensions are 16 inches in width by 24.5 inches in height by 35 inches in length

(48 inches when the tracks are horizontal), and it weighs 66 pounds. The robot's maximum speed is approximately 0.8 miles per hour, and its power is supplied by two 12-volt batteries on board and one at the control station. It has a small manipulator with a 24-inch horizontal reach and a 15-pound load capacity at full extension. The Mini-Andros has a fixed-position black-and-white camera mounted on the chassis and a color surveillance camera mounted on a pan-and-tilt mechanism. Signal transmission is accomplished via a 328-foot cable with freewheel unwind and a manual rewind. Wireless and fiberoptic communication options are available for the Mini-Andros.

3.2.5. Sensing

Most of the mobile robots come equipped with small video cameras. The cameras, some as small as lipstick containers, can be purchased from manufacturers such as Sony, Panasonic, and Toshiba; standard pan-and-tilt mechanisms are also commercially available. Radiation meters, multi-gas meters, photo-ionization detectors, and organic-vapor analyzers are also produced by a wide variety of manufacturers. However, they would have to be repackaged for robotic deployment.

3.2.6. Literature Survey Results

The literature survey was conducted to find technology to meet the strike teams' needs for a reconnaissance robot. As outlined previously, the strike team requires a mobile robot which can carry radiation, multi-gas, and photo-ionization meters as well as video cameras. The meters and cameras are available commercially, and a robot could be equipped with these items.

Strike teams must respond to emergencies in warehouse, barge, and ship environments. Robots that can traverse through a warehouse environment are commercially available; however, they would require modification to meet the strike teams' requirements. For example, most of the vehicles surveyed weighed significantly more than the 150-pound target for a strike team robot, many required an umbilical cable, and most were not explosion-proof and intrinsically safe. The robots available commercially could be customized to meet the needs of the strike teams in a warehouse environment. Barge and ship environments require a vehicle that can climb steep stairs and ladders and traverse a variety of obstacles. There is no commercial product which could maneuver in barge and ship environments. Also, the research surveyed showed that while these issues are being investigated, no commercial product has emerged to address these mobility issues.

3.3. Visits with Manufacturers

3.3.1. Denning Mobile Robots

Denning Mobile Robots, Inc., located in Pittsburgh, PA, designs and fabricates robots for security, industrial cleaning, and AGV applications. The company, established in 1982, produces three basic robots and has experience with a variety of sensor and navigation technologies.

The UTV-200 unmanned tow vehicle is an AGV which does not require floor tracks for guidance. Roboscrub is a robot designed to clean large floor areas. It uses lasers and other smart sensors for navigation and obstacle avoidance. The Sentry is a mobile vehicle designed to provide security either as a complement to human guards or on its own. In addition to these robots, Denning has experience with a variety of sensors, such as laser position and sonar range sensors, as well as with navigation technology.

Relative to the other manufacturers that were visited, Denning's products (1) have very sophisticated sensor-based automated navigation capabilities; (2) offer a wide variety of configuration options selectable from existing designs and off-the-shelf components; and (3) utilize a small, wheeled mobility mechanism that would have difficulty negotiating obstructions and obstacles. An interesting innovative design concept for an alternative mobility mechanism to meet the warehouse reconnaissance need was discussed, but Denning has not yet reduced these concepts to practice.

3.3.2. RedZone Robotics

RedZone Robotics, Inc., is a company located in Pittsburgh, PA, that specializes in designing and fabricating robotics equipment for environments too hazardous for human workers, such as nuclear power facilities and underground storage tanks. The company, established in 1987, has developed technology for decontamination and decommissioning, underground storage tank inspection and cleaning, and accident recovery. RedZone also operates machine vision and intelligent vehicles divisions which focus on industrial inspection systems and vehicle navigation systems respectively.

RedZone has developed a number of systems of interest to this project; a few of them are described in this section. Hercules is a semi-autonomous robot developed for the Environmental Protection Agency's Environmental Response Team. It is designed to respond to emergency situations in an outdoor setting. Houdini is a tethered, hydraulically-driven tracked system designed to work inside waste storage tanks. It has an expandable frame chassis that allows it to fit through confined entries as small as 24 inches. Fury is an automated robotic inspection system for underground fuel storage tanks. The robot is deployed through the tank's riser and conducts an ultrasonic inspection of the tank while the tank remains in service.

RedZone has not built a system designed specifically for warehouse, ship, or barge inspections. Most of their intelligent reconnaissance vehicles were designed for outdoor applications and

were built upon commercially-available, hydraulically-driven chassis. RedZone personnel were not aware of a commercial mobility device with the dexterity to traverse the barge and ship environments. With respect to the warehouse environment, they mentioned a robot called ARIES developed by the South Carolina Universities Research Education Foundation and managed by the Morgantown Energy Technology Center. It is designed for the routine visual inspection of low-level nuclear waste stored in warehouses and is built on a Cybermotion K3A wheeled platform. While the ARIES project shares some common goals with this project, ARIES is not designed for emergency responses to hazardous chemical spills and is not directly applicable technology.

3.3.3. Remotec

Remotec, located in Oak Ridge, TN, designs and fabricates robots for hazardous duty operations including law enforcement, military applications, and nuclear facility inspection. The company was established in 1980 and has over 300 robots in operation worldwide.

Remotec produces five basic remote vehicles. The Andros Mark V-A is a heavy-duty, all-terrain tracked mobile base. The Mark VI-A is a smaller version of the V-A designed specifically for operation in the aisles of commercial aircraft and in narrow building spaces. The Mini-Andros is a light-weight portable version of the Andros Mark V-A. The Andros 4X4 is a four-wheel drive vehicle equipped with oversized pneumatic tires for a cushioned, high-traction drive. Finally, the Andros 6X6 is a heavy-duty, six wheel drive vehicle capable of transporting payloads in excess of 1,000 pounds.

The Mini-Andros' small size and tracked mobility mechanism make it potentially attractive as a platform on which a prototype could be built for warehouse reconnaissance field tests. However, its sensor and control systems would have to be augmented substantially to give it the minimum capabilities that have been identified in this report. The necessary modifications and additions could be made by Remotec, by an R&D entity, or by another manufacturer (e.g., Denning or RedZone) with appropriate sensing and controls expertise.

3.4. Conceptual Design

This section will outline the conceptual design of a reconnaissance robot for hazardous response missions by Coast Guard strike teams. The design will be based on their requirements and the available technology. In general, the environments in which robots will operate dictate their designs; mobile robots are designed for very specific tasks. One which is designed to explore an active volcano would be much different than a vehicle which is designed to provide security for a warehouse. Some of the factors that affect the design of mobile robots are the terrain that must be traversed and the type of work that must be accomplished (inspection, construction, etc.). However, mobile systems generally do have some basic common elements:

- Mobility - The mechanics for the gross movement of the robot to a specified location.

- Measurement and Work - The primary sensors and tools deployed by the robotic system.
- Manipulation - The mechanics for the fine motion that position the primary sensor(s) and tool(s) at the desired locations.
- Monitoring and Control - The software responsible both for data acquisition and evaluation and for command and control of the system.

To design a robotic system, one must understand the robot's working environment and the robot's specific tasks. For the Coast Guard strike teams, three environments are of interest: warehouses, inland transfer areas (barges), and ships. The task in this application is to gather reconnaissance data for the strike teams. This knowledge can be utilized to synthesize a conceptual design of the system.

3.4.1. Mobility

First, the issue of mobility will be examined. Warehouses tend to be one level with spacious aisles; 55 gallon drums are stacked four or five high in this environment. Two types of mobility devices are ideal for warehouse work: wheeled and tracked vehicles. In the case of a response to a hazardous material spill, a tracked vehicle would be more desirable than a wheeled vehicle because the former can more easily traverse small obstacles and debris which may be present.

There is a wide variety of barge access platforms, although there are some common elements such as narrow walkways, ladders, ramps, and stairs. Three potential approaches are envisioned for this environment: legged, tracked, and airborne vehicles. The ship environment is similar to the barge environment because it also has narrow walkways, ladders, and steep stairs. A robot traversing through the passageways of a ship would have to deal with such obstacles. However, access to the cargo hold might be from the ship's deck. In this case, a robot could be lifted directly onto the deck, thus bypassing the need for the robot to navigate through the ship's passageways. Based on this information, legged, airborne, and tethered vehicles would be considered for a ship environment.

The answer to handling such diverse mobility requirements is to design and build multiple robots, each of which is designed for a specific environment. Clearly, the technology survey performed as part of this project indicated that robots capable of satisfying the mobility requirements of the warehouse environment are available. The survey also indicated that mobility devices with the dexterity to traverse barge and ship environments are not commercially available and that this issue is still being researched. The focus of this study is to design a system to meet the Coast Guard's needs using technology which is mature and presently available. Thus, the remainder of the section will concentrate on the conceptual design of a warehouse robot.

3.4.2. Measurement and Work

The following sensors will be included in the robot's primary sensor suite: radiation and multi-gas meters and either a photo-ionization detector or an organic-vapor analyzer. These meters are presently used by Coast Guard reconnaissance teams, and they will be used by the robot to gather data about the spilled chemicals. They are commercially-available units and will be packaged appropriately for robotic deployment and data acquisition. In addition, the vehicle will have sensors to detect temperature and smoke as well as microphones for audio capabilities. Other sensors will be added as appropriate.

The robot will carry video cameras and directional lighting on board. The cameras will serve two functions: to provide images of the hazardous site and to teleoperate the robot. The number of cameras required will be determined from experimentation and through guidance from strike team members. If there are problems with video images due to machine vibrations caused by rough terrain, electronic image stabilization techniques will be explored. Also, the system may benefit from the addition of three-dimensional vision capabilities, which could provide depth perception to the operators enabling more efficient teleoperation of the system; this issue should be explored during the detailed design of the robot. The cameras and meters will satisfy the requirements of the reconnaissance mission. The vehicle will also acquire samples of spilled items to bring back to the control area for testing and evaluation. The appropriate manipulation capabilities required to take samples will be added to the robot.

3.4.3. Manipulation

The warehouse robot will be targeted toward the initial reconnaissance mission of the strike teams. Specifically, it will deploy the sensors required to gather data about the spilled chemicals. The sensors will be mounted on the robot's chassis and do not require intricate manipulation. Video cameras to provide images of the contaminated area and for teleoperation of the robot will be mounted on the vehicle; they will have commercially-available pan, tilt, and zoom capabilities.

It is also desirable for the robot to acquire samples of spilled items. The manipulation capabilities to grab samples, including the ability to scoop solids and to capture gases and liquids, will be included. A standard six degree-of-freedom robotic arm mounted on the vehicle will satisfy the manipulation requirements for taking samples, and an appropriate end effector to take samples must be designed and fabricated.

3.4.4. Monitoring and Control

The system's processing capabilities will consist of a ground-based processor, which has high-level control of the system and displays the video images and sensor data, as well as an on-board processor, which controls low-level task sequencing and image and data acquisition. Communication between the two processors will be wireless. There will be an optional umbilical cable which carries communication and power lines, but during emergency situations, the cable could become entangled with obstructions that are present in the environment.

However, environments which prevent wireless communication may be encountered, and in these cases, the umbilical will be employed for communication between the computers. Power for the vehicle will normally be supplied by on-board batteries. If necessary, power will be supplied by using the optional umbilical cable.

Because the robot will be used in emergency situations, its response to operator instructions must be fast. Teleoperation will be used to control the robot; it will allow for much faster response than would an autonomous system. The operator workstation will have controls for vehicle steering and speed. It will also have video monitors to provide camera images to be used by the operators for navigation and for visual assessment of the hazardous area. Additional computer-assisted control of the device could be added if it is found to improve the system's response time.

3.4.5. Design

The previous sections have summarized the conceptual design of the robotic system in the areas of mobility, measurement and work, manipulation, and monitoring and control. The following illustration is an artist's concept of how a warehouse reconnaissance robot might look.

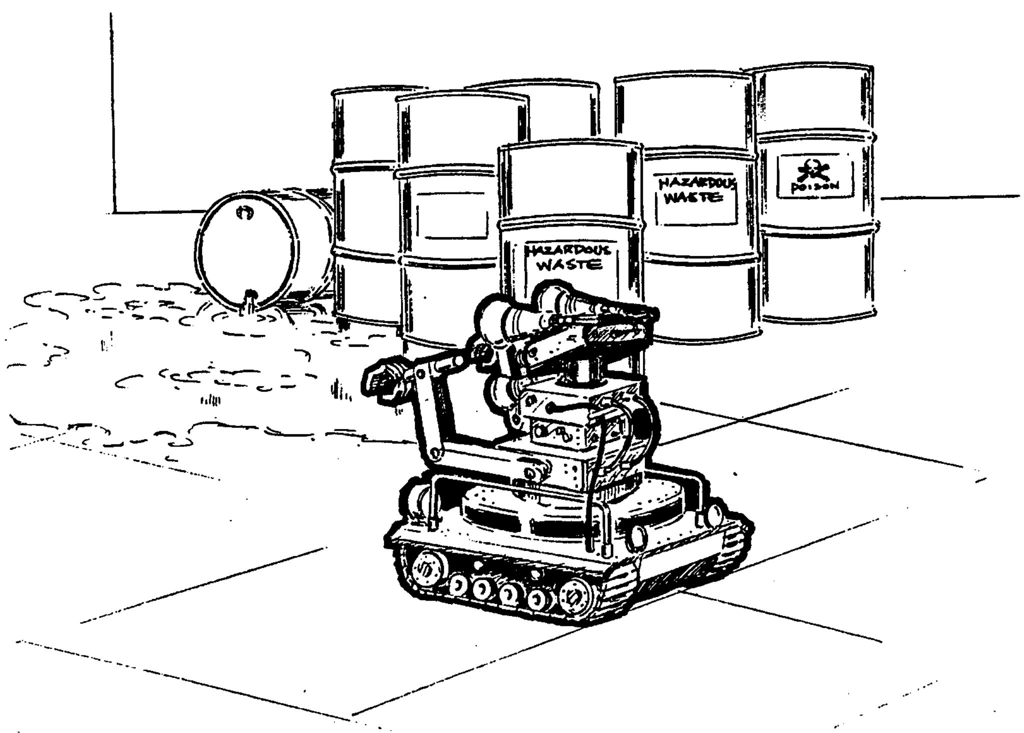

Figure 1 Artist's Illustration of a Coast Guard Warehouse Reconnaissance Robot

The basic requirements of the warehouse robot are summarized in the following list.

- Robot
  - Tracked vehicle for flat and irregular terrain - a target maximum weight of 150 pounds

- Physical dimensions will not exceed 3 feet in either length or width
- Intrinsically-safe and explosion-proof vehicle, meeting OSHA Class I Div. I requirements
- Waterproof for decontamination procedures but nonsubmersible
- On-board processor controlling low-level task sequencing, image and data acquisition, and communications
- On-board battery power lasting at least 3 hours between recharges
- On-board video cameras with pan, tilt, and zoom features (three-dimensional vision system optional)
- Top speed of between 1 and 5 miles per hour
- Operational in a normal outdoor temperature range of -20° F to 130° F.
- Arm with end effector to grab samples

- Primary Sensing
  - Radiation meter
  - Multi-gas meter
  - Photo-ionization detector or organic-vapor analyzer
  - Temperature sensor
  - Smoke sensor
  - On-board microphones
- Communications
  - Wireless communication between the ground-based and on-board processors.
  - An optional umbilical cable which carries communication and power lines
- Operator workstation
  - Ground-based processor with high-level control of the system and video and data display capabilities.
  - Teleoperation control panel with vehicle speed and steering controls
  - Video monitors for operator to provide images for navigation and visual assessment of the hazardous area.

Figure 2 depicts the schematic view of the warehouse robot. It is important to note that the design may change when more is learned as the robot is designed in detail.

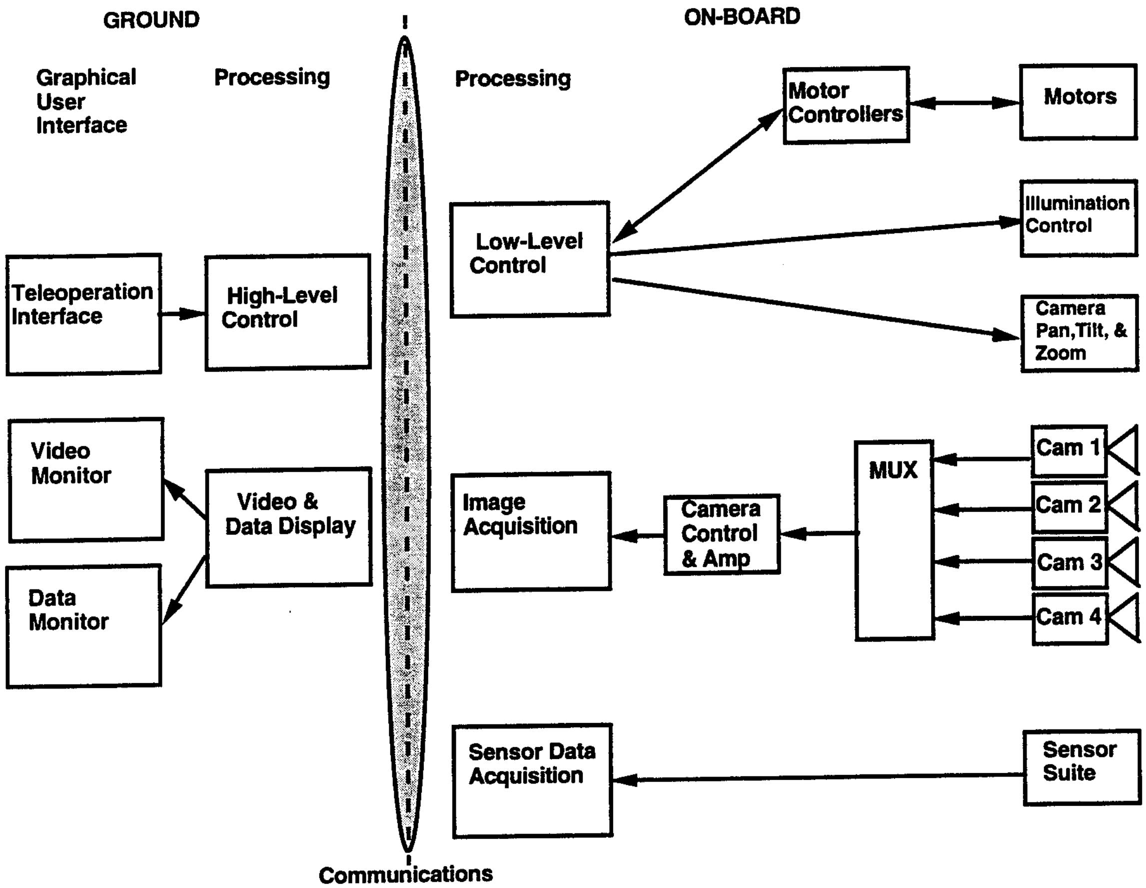

Figure 2 Schematic of a Warehouse Reconnaissance Robot

The robotic system shown and described above will perform reconnaissance missions for the Coast Guard in warehouse situations. This will remove the need for sending people to do this task and will reduce risks to the health and safety of strike team personnel.

The principles used in the development of the warehouse robot can be extended to barge and ship situations as the corresponding technology becomes more mature. At the present time, adequate mobility devices for barge and ship reconnaissance robots are not sufficiently developed. The functional designs for such robots are identical to that shown in Figure 2; however, their implementations will differ greatly from that shown in Figure 1.

Finally, this study has shown that the technology is available in the areas of mobility, measurement and work, manipulation, and monitoring and control to take an important step towards providing useful robotic tools for Coast Guard strike teams.

4. Conclusions

- Strike teams must respond to emergencies in warehouse, barge, and ship environments.
- The solution to handling diverse mobility required by warehouse, barge, and ship environments is to design and build multiple robots, each of which is designed for a specific environment.
- Robots that can traverse through a warehouse environment are commercially available; however, they would require modification to meet the strike teams' requirements. Most of the vehicles surveyed weighed significantly more than the 150-pound target for a strike team robot, many required an umbilical cable, and most were not explosion-proof and intrinsically safe. The robots available commercially could be customized to meet the needs of the strike teams in a warehouse environment.
- Barge and ship environments require a vehicle that can climb steep stairs and ladders and traverse a variety of obstacles. There is no commercial product which could maneuver in barge and ship environments. Also, the research surveyed showed that while these issues are being addressed, no technology has emerged to address these mobility problems.
- The following sensors need to be included in the Coast Guard robot's primary sensor suite: radiation and multi-gas meters and either a photo-ionization detector or an organic-vapor analyzer. They are commercially-available units and will be packaged appropriately for robotic deployment and data acquisition. In addition, the vehicle will have sensors to detect temperature and smoke as well as microphones for audio capabilities.
- The Coast Guard robot should carry video cameras and directional lighting on board to provide images of the hazardous site and for teleoperation of the robot. The system may benefit from the addition of three-dimensional vision capabilities.
- One of a selection of commercially-available, six degree-of-freedom robotic arms will be mounted on the vehicle to take solid, gas, and liquid samples. An appropriate end effector to take samples will be designed and fabricated.
- The system processing will consist of a ground-based processor, which has high-level control of the system and displays the video images and sensor data, as well as an on-board processor, which controls low-level task sequencing and image and data acquisition.
- Wireless communication between the robot and the operator workstation will usually be employed, and the robot will have on-board battery power. An umbilical cable with communication and power lines will be provided for situations where wireless communication and/or on-board power is inadequate.

- For fast response time, teleoperation will be used to control the robot. The operator workstation will have controls for vehicle steering and speed. It will also have video monitors to provide camera images to be used by the operators for navigation and for visual assessment of the hazardous area.

5. References

1. Satush S. Nair, "Overview of the Features of a Legged Locomotion System for Unstructured Environments," Automation of Construction 1, pp. 361-370, 1993.

2. Yutaka Tanaka and Yasunori Matoba, "Study of an Intelligent Hexapod Walking Robot," IEEE/RSJ International Workshop on Intelligent Robots and Systems, IROS '91, November 1991.

3. H.W. Stone and G. Edmonds, "Hazbot: A Hazardous Material Emergency Response Mobile Robot," Proceedings of the 1992 IEEE International Conference on Robotics and Automation, Nice, France, May 1992.

4. "Where There's Danger, Call Hazbot," NASA Tech Briefs, Vol. 17 No. 10, pp. 16-18, October 1993.

6. Appendix A: Literature Search Bibliography

Author Nakamura, H.; Shimada, T.; Kobayashi, H.;
Dept. of Electr. Eng., Hosei Univ., Tokyo, Japan
Title An INSPECTION ROBOT for feeder cables-snake like motion control
Source Proceedings of the 1992 International Conference on Industrial Electronics, Control, Instrumentation, and Automation. Power Electronics and Motion Control (Cat. No.92CH3137-7); San Diego, CA, USA; 9-13 Nov. 1992;
Sponsored by: IEEE; Soc. Instrum. Control Eng. Japan;
New York, NY, USA; IEEE; 3 vol. 1649 pp.; 1992 pp.; pp. 849-52 vol.2 pp.
Abstract The authors discuss the basic control structure for an INSPECTION ROBOT for feeder cables. Since the feeder cables stretch over an extremely long distance, automatic INSPECTION is necessary. Feeder cables have many irregular points, i.e feeder branches, insulators, and so on, and thus development of such robots is difficult. As a first stage of the development, an attempt has been made to build a prototype which can pass through vertical-type irregular points. The prototype has a multicar structure with joint connections and a snakelike motion control architecture. The mechanical structure and control architecture are described, and it is shown that such a ROBOT can run on the cable smoothly with enough speed, and can avoid vertical irregular points
Thesaurus INSPECTION; mobile robots; position control; power overhead lines
Other Terms railways; INSPECTION ROBOT; feeder cables; snake like motion control; control structure; feeder branches; insulators; vertical-type irregular points; multicar structure; mechanical structure
ClassCodes B8130F; B0170L; C3390; C3120C
Article Type Practical
Language English
RecordType Conference
ControlNo. 4518377
AbstractNos. B9312-8130F-013; C9312-3390-099
ISBN or SBN 0 7803 0582 5
References 7
U.S. Copyright Clearance Center Code
0 7803 0582 5/92/$3.00
Country Pub. USA
date 1207

Author Yamaguchi, T.; Yoshida, S.; Takatsuka, K.; Kobayashi, N.;
Tokyo Electric Power Co., Japan

Title Conduit INSPECTION ROBOT and small conduit after-laying method

Source 12th International Conference on Electricity Distribution.
CIRED (Conf. Publ. No.373); Birmingham, UK; 17-21 May 1993;
Sponsored by: IEE;
London, UK; IEE; 7 vol. 1006 pp.; 1993 pp.; pp. 3.23/1-4 vol.3
pp.

Abstract The construction of a new optical fiber cable communication system involves the costly operation of installing the cables underground, and, in addition, such installation work is subject to numerous regulations. It is therefore preferable, to incorporate new optical fiber cables within existing conduit, into which power cable has already been installed. However, if any collapse or blockage has occurred within the existing power cable conduit, this may make the inclusion of optical fiber cables impracticable. Therefore, it is necessary to have a device which is capable of inspecting the condition inside of the existing power cable conduit, prior to the optical fiber cables being installed. Tokyo Electric Power Company and Fujikura Ltd. have jointly developed the self-advancing conduit INSPECTION ROBOT, and the 'small conduit after-laying method' for including a small conduit for optical fiber cables, within an existing power cable conduit. The Authors describe the ROBOT and experience with it in practice

Thesaurus cable laying; electric conduits; INSPECTION; optical cables; robots

Other Terms small conduit after-laying method; optical fiber cable communication system; Tokyo Electric Power Company; Fujikura; self-advancing conduit INSPECTION ROBOT; power cable conduit

ClassCodes B8130H; B6260; B0170L; C3390

Article Type Practical

Language English

RecordType Conference

ControlNo. 4432662

AbstractNos. B9308-8130H-005; C9308-3390-035

ISBN or SBN 0 85296 561 3

References 0

Country Pub. UK

date 1214

Author Kobayashi, H.; Nakamura, H.; Shimada, T.;
Dept. of Electr. Eng., Hosei Univ., Tokyo, Japan

Title An INSPECTION ROBOT for feeder cables-Basic structure and control

Source Proceedings IECON '91. 1991 International Conference on Industrial Electrlnics, Control and Instrumentation (Cat. No. 91CH2976-9); Kobe, Japan; 28 Oct.-1 Nov. 1991;
Sponsored by: IEEE; Soc. Instrum. & Control Eng. Japan;
New York, NY, USA; IEEE; 3 vol. 2591 pp.; 1991 pp.; pp. 992-5 vol.2 pp.

Abstract The authors describe a basic synthesis concept for an INSPECTION ROBOT for feeder cables (electric power cables for railways). Since the feeder cables are extremely long and have many irregular points, i.e., feeder branches, insulators and so on, robots running on these cables should have elaborate structures. A multicar structure with joint connections and biological control architecture was adopted; thus, the ROBOT can run on the cable smoothly with enough speed and avoid the irregular points. It has a fail-safe structure as a result of autonomous distributed control. The mechanical structure of the ROBOT and the control strategy for avoiding the irregular points are discussed

Thesaurus control system synthesis; distributed control; INSPECTION; power cables; railways; robots

Other Terms control system synthesis; INSPECTION ROBOT; feeder cables; electric power cables; railways; multicar structure; biological control architecture; autonomous distributed control; control strategy

ClassCodes B8520; B8130B; C3390; C1310; C3360D

Article Type Practical; Theoretical / Mathematical

Language English

RecordType Conference

ControlNo. 4280498

AbstractNos. B9212-8520-046; C9212-3390-111

ISBN or SBN 0 87942 688 8

References 6

U.S. Copyright Clearance Center Code
CH2976-9/91/0000-0992$01.00

Country Pub. USA

date 1193

Author Hori, M.; Niimura, T.; Miura, M.; Fujisawa, T.; Satou, T.; Morimoto, T.; Moriya, S.
Title Development of INSPECTION ROBOT for penstocks
Source NKK Technical Report;
NKK Tech. Rep. (Japan); no.131; 1990 pp.; pp. 35-45 pp.
Abstract Electric Power Co. and NKK have developed INSPECTION ROBOT for penstocks. This ROBOT system is composed of an INSPECTION ROBOT, measuring equipment, an observation carriage, a cable drum, and controllers. These parts are inserted from a manhole and constructed in the penstock. The ROBOT can travel in spiral 3.5 approximately 5.0 m penstocks, can pass through 3D bends and climb a 50 degrees slope, whilst observing corrosion of the penstock surface and measuring pipe walls and coating thicknesses. The authors describe the ROBOT system, and give the results of experiments and field-tests
Thesaurus industrial robots; INSPECTION
Other Terms industrial robots; penstocks; INSPECTION ROBOT; measuring equipment; controllers
ClassCodes B0170L; C3390; C7420
Article Type Applications; Practical
Coden NKKGEF
Language Japanese
RecordType Journal
ControlNo. 3772015
AbstractNos. B90074591; C91002309
ISSN 09150536
References 0
Country Pub. Japan
date 1171

Author Tsuge, M.;
Japan Society of Precision Eng., Tokyo, Japan
Title INSPECTION ROBOT of spherical gas storage tanks
Source Journal of the Japan Society of Precision Engineering;
J. Jpn. Soc. Precis. Eng. (Japan); vol.56, no.2; Feb. 1990 pp.;
pp. 287-91 pp.
Abstract The spherical gas storage tank is a facility indispensable for stable supply of town gas and it is opened periodically in 5-10 years for inspections of welded lines on the surfaces of both sides. Since the INSPECTION requires a long period (a half year) and much cost, it has been strongly requested to develop an automatized system for INSPECTION, and technology to enable inspections without stopping operations. In order to meet these requirements, Tokyo Gas Company has developed the INSPECTION ROBOT equipped with ultrasound probes, which can carry out inspections of the butt weld section of the spherical shell and the fillet weld section between the strut and the shell of the tank
Thesaurus industrial robots; INSPECTION; ultrasonic materials testing
Other Terms spherical gas storage tanks; Tokyo Gas Company; INSPECTION ROBOT; ultrasound probes; butt weld; fillet weld
ClassCodes A4385; B0160; B0590; C3390; C7420
Article Type Practical
Coden JJPEAD
Language Japanese
RecordType Journal
ControlNo. 3736853
AbstractNos. A90131263; B90067953; C90062739
ISSN 09120289
Country Pub. Japan
date 1172

Author Takenaka, T.; Oya, T.
Title INSPECTION robots (nuclear power stations)
Source Mitsubishi Denki Giho;
Mitsubishi Denki Giho (Japan); vol.64, no.3; 1990 pp.; pp. 44-9 pp.
Abstract Inspections of nuclear power plants make it possible to achieve and maintain high levels of plant reliability and availability. The Kansai Electric Power Corporation is developing robots to perform INSPECTION tasks. The benefits of ROBOT use include maintaining higher surveillance levels, reducing occupational radiation exposure, and reduced labor costs. The authors introduce two fully developed products: a remote INSPECTION ROBOT for use inside nuclear reactor containment vessels; and a remote INSPECTION and repair ROBOT for use inside the vacuum vessel of the JT-60 nuclear-fusion critical plasma test reactor. They also describe a prototype automatic INSPECTION ROBOT that detects abnormalities using video and infrared cameras and an image-processing system
Thesaurus fission reactor safety; fusion reactor safety; INSPECTION; mobile robots; nuclear power stations; television cameras
Other Terms remote repair ROBOT; video cameras; abnormality detection; nuclear power stations; reliability; availability; Kansai Electric Power Corporation; surveillance; occupational radiation exposure; labor costs; remote INSPECTION ROBOT; nuclear reactor containment vessels; JT-60 nuclear-fusion critical plasma test reactor; infrared cameras; image-processing system
ClassCodes A2844; A2852N; B8220; B0170L; B6430J; C3390
Article Type Practical
Coden MTDNAF
Language Japanese
RecordType Journal
ControlNo. 3714577
AbstractNos. A90115712; B90066828; C90056326
ISSN 03692302
References 6
Country Pub. Japan
date 1171

Author Fujita, A.;
Pipeline Eng. Dev. Center, Tokyo Gas Co. Ltd., Japan
Title INSPECTION robots for gas mains
Source ROBOT;
ROBOT (Japan); no.69; July 1989 pp.; pp. 29-34 pp.
Abstract Robots which perform several kinds of work in gas mains have been developed. This paper describes wheel-type INSPECTION robots for pipes of diameter 50 mm and 100 mm, an inchworm type INSPECTION ROBOT, a traction type INSPECTION ROBOT and a pressurized pig type INSPECTION ROBOT for gas mains more than 100 mm in diameter
Thesaurus INSPECTION; mobile robots; natural gas technology
Other Terms gas mains; wheel-type INSPECTION robots; inchworm type INSPECTION ROBOT; traction type INSPECTION ROBOT; pressurized pig type INSPECTION ROBOT; 50 mm; 100 mm
ClassCodes C3310E; C7420; C3390
Article Type Practical
Numerical size 5.0E-02 m; size 1.0E-01 m
Coden ROBBDQ
Language Japanese
RecordType Journal
ControlNo. 3571345
AbstractNos. C90019071
ISSN 03871940
References 5
Country Pub. Japan
date 1164

Author Takeda, T.; Kato, A.;
Komatsu Ltd., Kanagawa, Japan
Title Cleanroom INSPECTION ROBOT
Source Automated Guided Vehicle Systems. Proceedings of the 5th International Conference: AGVS-5; Tokyo, Japan; 6-8 Oct. 1987; Sponsored by: IFS (Conferences); Japanese Council Phys. Distribution Manage.; et al;
Kempston, Bedford, UK; IFS (Publications); vii+327 pp.; Oct. 1987 pp.; pp. 277-87 pp.
Editor Takahashi, T.
Abstract A ROBOT is proposed for the difficult and tedious two-man task of cleanroom INSPECTION. It consists of a Spotmark guided AGV, a manipulator to scan the measuring probe, and a particle counter. There are two important types of examination in cleanroom INSPECTION. One is the leak test, to check whether there are leaks in the air filter. The other is the cleanliness test, to examine the cleanliness of the room's atmosphere
Thesaurus automatic test equipment; industrial robots; INSPECTION; semiconductor technology
Other Terms INSPECTION ROBOT; cleanroom INSPECTION; Spotmark guided AGV; particle counter; leak test; air filter
ClassCodes B7210B; B2550; B2570; B0170L; B0170E; C3390; C7410H
Article Type Practical
Language English
RecordType Conference
ControlNo. 3277332
AbstractNos. B89005272; C89001487
ISBN or SBN 0 948507 56 X
References 3
Country Pub. UK
date 1141

Author Takemoto, Y.; Kunimoto, I.; Hishikawa, K.; Shiokawa, T.; Inoue, Y.; Nishioka, T.;
R&D Group for Constr. Robots, Ohbayashi Corp., Osaka, Japan
Title Construction robots of Ohbayashi Corporation
Source ROBOT;
ROBOT (Japan); no.58; A03; June 1987 pp.; pp. 19-29 pp.
Abstract The paper introduces some construction and INSPECTION robots developed recently by Ohbayashi Corporation, Japan namely Autoclamp and Autoclaw, which are automatic clamping devices for using in safe construction of steel frames; Placing-crane, an automatically controlled crane for concrete distribution and material lifting; On-floor ROBOT, an automatically controlled tractor for trowelling and some other jobs on the concrete floor, KABEDODER, a self-driving INSPECTION ROBOT for the surface of building walls; and CIMRO, a clean-room investigating and monitoring ROBOT. The paper describes the purposes and circumstances of development, the main specifications and functional characteristics, the evaluations in actual use, and the future technical problems, for each ROBOT
Thesaurus building; construction industry; industrial robots; INSPECTION
Other Terms construction robots; steel frame construction; wall surface INSPECTION; Ohbayashi Corporation; Japan; Autoclamp; Autoclaw; clamping devices; Placing-crane; concrete distribution; material lifting; On-floor ROBOT; tractor; trowelling; KABEDODER; self-driving INSPECTION ROBOT; building walls; CIMRO; clean-room
ClassCodes C3330; C3390
Article Type Practical
Coden ROBBDQ
Language Japanese
RecordType Journal
ControlNo. 3061813
AbstractNos. C88011413
ISSN 03871940
References 0
Country Pub. Japan
date 1137

Author Hosohara, Y.; Fujita, A.; Mori, K.; Kurita, S.; Sakamoto, K.; Naito, S.;
Pipeline Eng. Dev. Center, Tokyo Gas Co. Ltd., Japan
Title Development of INSPECTION robots for small pipe lines
Source Hitachi Review;
Hitachi Rev. (Japan); vol.36, no.2; A06; April 1987 pp.; pp. 79-84 pp.
Abstract The extended length of buried pipe line of the city gas throughout Japan reaches approximately 150000 km. In order to secure safety for these buried gas pipe lines, it is necessary to detect unusual conditions such as cracks, defects or corrosion on the surfaces of pipes, and thereby preventing potential accident caused by gas leakage. Under these circumstances, Tokyo Gas Co., Ltd., and Hitachi, Ltd., have jointly developed a practical INSPECTION ROBOT system for the pipe lines of 2 B diameter, which automatically carries out INSPECTION within the complicated gas pipe line including branch elbows, etc., and as well there has been established automatic INSPECTION technology for small-bore gas pipe lines
Thesaurus INSPECTION; robots
Other Terms 2 B pipe line diameter; unusual condition detection; buried gas pipe lines; cracks; defects; corrosion; Tokyo Gas Co., Ltd.; Hitachi, Ltd.; INSPECTION ROBOT system; branch elbows; small-bore gas pipe lines
ClassCodes C3330; C3390; C3395
Article Type Practical
Coden HITAAQ
Language English
RecordType Journal
ControlNo. 3023772
AbstractNos. C88001313
ISSN 0018277X
References 0
Country Pub. Japan
date 1135

Author Stone, H.W.; Edmonds, G.;
Jet Propulsion Lab., California Inst. of Technol., Pasadena, CA, USA
Title HAZBOT: a hazardous materials emergency response mobile ROBOT
Source Proceedings. 1992 IEEE International Conference on Robotics And Automation (Cat. No.92CH3140-1); Nice, France; 12-14 May 1992;
Sponsored by: IEEE;
Los Alamitos, CA, USA; IEEE Comput. Soc. Press; 3 vol. xxxix+2819 pp.; 1992 pp.; pp. 67-73 vol.1 pp.
Abstract The authors describe the progress that has been made towards the development of a remotely controlled mobile ROBOT that can be used by hazardous materials emergency response teams to perform a variety of tasks including incident localization and characterization, hazardous material identification/classification, site surveillance and monitoring, and ultimately incident mitigation. In its first end-to-end demonstration, the HAZBOT II vehicle navigated to the incident location from a distant (150-200 ft.) DEPLOYMENT site; entered a building through a door with thumb latch style handle and door closer; located and navigated to the suspected incident location (a chemical storeroom); unlocked and opened the storeroom's door; climbed over the storeroom's 12 in. high threshold to enter the storeroom; and located and identified a broken container of benzene
Thesaurus accidents; mobile robots; telecontrol
Other Terms incident characterization; hazardous materials identification; hazardous materials characterization; door handle; site monitoring; hazardous materials emergency response mobile ROBOT; remotely controlled mobile ROBOT; incident localization; site surveillance; incident mitigation; HAZBOT II; thumb latch style handle; door closer; broken container; 150 to 200 ft
ClassCodes B6210J; C3390; C7420; C3250
Article Type Practical
Numerical distance 4.6E+01 to 6.1E+01 m
Language English
RecordType Conference
ControlNo. 4358932
AbstractNos. B9304-6210J-005; C9304-3390-050
ISBN or SBN 0 8186 2720 4
References 5
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Country Pub. USA
date 1201

Author Yoshikawa, H.;
Fac. of Eng., Tokyo Univ., Japan
Title Robotics in extreme environments
Source Journal of the Institute of Electronics, Information and Communication Engineers;
J. Inst. Electron. Inf. Commun. Eng. (Japan); vol.70, no.2; T10 ; Feb. 1987 pp.; pp. 183-6 pp.
Abstract A project called 'Robotics in Extreme Environments' was started in accordance with MITI's Large Industrial Technology Development Project in 1983. This Project has its objective of manufacturing three kinds of robots by trial: the MAINTENANCE ROBOT for nuclear power plant facilities, the MAINTENANCE ROBOT for marine construction and the rescue ROBOT for emergency in the case of a disaster. Many difficult design problems occur due to the extreme environments being quite different from those of general manufacturing plants. Robotics in extreme environments must be autonomous in operations and be operated under physically bad environments, which requires completely new concepts for mechanical design, artificial intelligence, control theory, sensors, actuators, materials, and power sources
Thesaurus robots
Other Terms MITI; extreme environments; MAINTENANCE ROBOT; nuclear power plant; marine construction; rescue ROBOT; emergency; artificial intelligence; control theory; sensors; actuators; materials; power sources
ClassCodes C3390
Article Type Practical
Coden DJTGEB
Language Japanese
RecordType Journal
ControlNo. 3044798
AbstractNos. C88006782
ISSN 03736121
References 0
Country Pub. Japan
date 1133

Author Yavnai, A.
Title Sensor architecture for mobile CONSTRUCTION ROBOT
Source Fourth International Symposium on Robotics and Artificial Intellegence in Building CONSTRUCTION; Haifa, Israel; 22-25 June 1987;
Haifa, Israel; Technion; 2 vol. (xxxv+vii+918) pp.; 1988 pp.; p p. 119-37 vol.1 pp.

Abstract The operation of a semi-autonomous self-guiding mobile CONSTRUCTION ROBOT in a real building CONSTRUCTION environment relies heavily on a sensor-based intelligent hierarchical control system. A multi-sensor architecture, consisting of a variety of sensor types and technologies is proposed. The architecture is designed to meet both operational and mission-specific sensing requirements. Data processing issues are not covered in this paper

Thesaurus building; electric sensing devices; industrial robots; mobile robots
Other Terms operational requirements; semi-autonomous self-guiding mobile CONSTRUCTION ROBOT; building CONSTRUCTION environment; sensor-based intelligent hierarchical control system; multi-sensor architecture; mission-specific sensing requirements
ClassCodes C3330; C3390; C3240D
Article Type Practical
Language English
RecordType Conference
ControlNo. 3405609
AbstractNos. C89041926
References 6
Country Pub. Israel
date 1137

Author Lin Cun; Maxie-Fong; Diao Shu-Jie; Liu Nai-Rong; Wei Tong-Po;
Dept. of Eng., Shenyang, Polytech. Univ., China

Title A vision system for accurate positioning of carrier ROBOT in the automated WAREHOUSE

Source ICARCV '92. Second International Conference on Automation, Robotics and Computer Vision; Singapore; 16-18 Sept. 1992;
Sponsored by: IEE; Inst. Meas.& Control; Econom. Development Board; et al;
Singapore; Nanyang Technol. Univ; 3 vol.
(viii+934+viii+861+vii+908) pp.; 1992 pp.; pp. CV-12.8/1-4 vol. 1 pp.

Abstract The vision system of carrier ROBOT is presented, which is operated in a high-density, heavy-load WAREHOUSE. The system is especially designed for the carrier ROBOT to meet the high precision positioning requirements. In the system, the images of goods shelves are captured dynamically by a CCD camera, and then processed by a microcomputer. Finally, the accurate locations of the goods shelves are used to guide the ROBOT for accurate positioning

Thesaurus computer vision; computerised navigation; mobile robots; position control; WAREHOUSE automation

Other Terms computer vision; accurate positioning; carrier ROBOT; automated WAREHOUSE; CCD camera

ClassCodes C5260B; C3320; C3390; C3120C

Article Type Practical

Language English

RecordType Conference

ControlNo. 4575688

AbstractNos. C9402-5260B-126

References 3

Country Pub. Singapore

date 1205

Author Hollingum, J.
Title Caterpillar make the earth move: automatically (self guided vehicles)
Source Industrial ROBOT;
Ind. ROBOT (UK); vol.18, no.2; 1991 pp.; pp. 15-18 pp.
Abstract The author looks at the Caterpillar's self-guided vehicles (SGVs), the free-range trucks which are distinguished from vehicles using inductive wires or other floor guidance systems. SGVs follow routes which are determined not by road markers of any kind but by software in the control system. They keep track of their position by taking bearings from bar-coded targets placed around the factory or WAREHOUSE where they are working, supplemented by odometry-dead reckoning-from the rotation and direction of the road wheels. The guidance system at the heart of the Caterpillar SGV consists of three basic elements: a truck, which was called the Turtle, using laser navigation and odometry; a control system called the Landbase; and a communication system using a UHF/FM radio link
Thesaurus automatic guided vehicles; computerised navigation; position control; radio links
Other Terms Caterpillar; self-guided vehicles; free-range trucks; bar-coded targets; factory; WAREHOUSE; odometry; dead reckoning ; Turtle; laser navigation; Landbase; UHF/FM radio link
ClassCodes C3320; C7420; C3120C
Article Type Practical
Coden IDRBAT
Language English
RecordType Journal
ControlNo. 3980873
AbstractNos. C91062944
ISSN 0143991X
References 0
Country Pub. UK
date 1184

Author Carrara, G.; De Paulis, A.; Tantussi, G.;
Dipartimento di Sistemi Elettrici e Automazione, Pisa Univ., Italy

Title SSR: a mobile ROBOT on ferromagnetic surfaces

Source Automation in Construction;
Autom. Constr. (Netherlands); vol.1, no.1; May 1992 pp.; pp. 47-53 pp.

Abstract The design, assembly and testing of an original, electrically controlled automatic mechanism (ROBOT) is discussed. The device is capable of moving on flat surfaces made of ferromagnetic materials, however inclined with respect to gravity. SSR is an acronym of square shaped ROBOT. The ROBOT is used for SHIP maintenance

Thesaurus mobile robots; ships

Other Terms mobile ROBOT; electrically controlled automatic mechanism; flat surfaces; ferromagnetic materials; square shaped ROBOT; SHIP maintenance

ClassCodes C7420; C3390; C7440

Article Type Practical

Coden AUCOES

Language English

RecordType Journal

ControlNo. 4274008

AbstractNos. C9212-7420-045

ISSN 09265805

References 2

Country Pub. Netherlands

date 1201

Author Bradshaw, A.;
Lancaster Univ., UK
Title The UK Security and Fire Fighting Advanced ROBOT project
Source IEE Colloquium on 'Advanced Robotic Initiatives in the UK' (Digest No.081); London, UK; 17 April 1991;
Sponsored by: IEE;
London, UK; IEE; 32 pp.; 1991 pp.; pp. 1/1-4 pp.
Abstract Describes the current status of the UK's Security and Fire Fighting Advanced ROBOT (SAFFAR) project within the International Advanced Robotic Programme (IARP). In the UK the majority of nondomestic fire losses are as a result of arson. The SAFFAR ROBOT is intended as a relatively low cost high performance device which will act as a powerful deterrent to unauthorised intrusion into a premises by markedly increasing the incidence of arrest of such intruders. It also carries a 'first strike' fire fighting capability which should prevent, for example petrol bomb fires, from taking HOLD. The ROBOT design concept has been to provide varying levels of performance complexity (and associated costs), by stand alone 'modules' for both hardware and software elements which can then be 'assembled' into a variety of core designs and variants
Thesaurus fires; mobile robots; project engineering
Other Terms mobile robots; UK Security and Fire Fighting Advanced ROBOT project; SAFFAR; design concept
ClassCodes C3390
Article Type Practical
Language English
RecordType Conference
ControlNo. 3968003
AbstractNos. C91057031
References 0
Country Pub. UK
date 1187

Author Cook, D.J.;
Dept. of Comput. Sci., Texas Univ., Arlington, TX, USA
Title Using analytic and genetic methods to learn plans for mobile robots
Source Applications of Artificial Intelligence 1993: Machine Vision and Robotics; Orlando, FL, USA; 14-16 April 1993;
Sponsored by: SPIE;
Proceedings of the SPIE - The International Society for Optical Engineering; vol.1964; 1993 pp.; pp. 327-36 pp.
Abstract A small mobile ROBOT can be of great use in exploring environments, maneuvering through dangerous areas, identifying and tracking objects, and carrying CARGO. Current methods of planning for robots focus on heavy on-board processing making use of multiple goals, learning, and failure recovering, or they focus on using very little on-board power running small reactive plans. We describe a method that makes use of both types of planning. While an on-board processor can generate small reactive plans for one particular goal, an off-site computer can perform goal management and learn from the ROBOT's failures and successes to modify the rule base for the ROBOT's future plans. This paper describes these ideas and illustrates their use on a T1 mobile ROBOT
Thesaurus computerised navigation; learning (artificial intelligence); mobile robots; path planning
Other Terms analytic methods; reactive planning; path planning; plan learning; genetic methods; on-board processing; learning; failure recovering; goal management; rule base; T1 mobile ROBOT
ClassCodes C3390; C3120C; C1230; C7420; C6170
Article Type Practical; Experimental
Coden PSISDG
Language English
RecordType Conference
ControlNo. 4603617
AbstractNos. C9404-3390-007
ISSN 0277786X
References 14
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Country Pub. USA
date 1213

Author Krishnamurthy, B.; Barrows, B.; King, S.; Skewis, T.; Will Pong ; Weiman, C.;
Transitions Res. Corp., Danbury, CT, USA

Title HelpMate: a mobile ROBOT for transport applications

Source Mobile Robots III; Cambridge, MA, USA; 10-11 Nov. 1988; Sponsored by: SPIE;
Proceedings of the SPIE - The International Society for Optical Engineering; vol.1007; 1989 pp.; pp. 314-20 pp.

Abstract HelpMate is a mobile robotic materials transport system that performs fetch and carry tasks at Danbury Hospital, (Connecticut, USA). It navigates along the main arteries of the hospital, crossing between buildings via interconnecting corridors and uses infrared communication links to communicate with the elevator controller. HelpMate has been designed to work safely around humans, smoothly re-routing its local path to avoid obstacles while maintaining its mission. Safety features include both noncontact and contact obstacle sensing, emergency stop switches, auto/manual mode switches, flashing warning lights, turn indicators, and a failsafe controls design. HelpMate uses odometry, sonar and infrared proximity sensors, and vision as navigation inputs. An onboard card reader provides authorized personnel access to run time control and CARGO transfer. Sensor information collected en route is used to build and maintain local navigation maps. A general knowledge of the structured properties of the world is assumed, and used both in collecting and rationalizing the sensor information and updating the ROBOT's local knowledge base. All navigation and path planning is conducted under the direction of onboard processors

Thesaurus complete computer programs; computer vision; computerised materials handling; computerised navigation; health care; knowledge based systems; mobile robots; optical communication ; position control; safety systems

Other Terms obstacle avoidance; safety features; noncontact obstacle sensing; mobile ROBOT; HelpMate; materials transport system; Danbury Hospital; infrared communication links; elevator controller; re-routing; contact obstacle sensing; emergency stop switches; auto/manual mode switches; flashing warning lights; turn indicators; failsafe controls design; odometry; sonar; infrared proximity sensors; vision; navigation inputs; onboard card reader; local knowledge base

ClassCodes C6170; C5260B; C3320; C3385; C7420; C7330; C3120C; C3390

Article Type Practical

Coden PSISDG

Language English

RecordType Conference

ControlNo. 3400658

AbstractNos. C89043622

ISSN 0277786X

References 13

Country Pub. USA

date 1155

Author Stoney, G.; Drane, C.R.; Leaney, J.; Walker, B.; Semler, D.;
Sch. of Electr. Eng., Univ. of Technol., Sydney, NSW, Australia

Title An autonomous mobile ROBOT control system using subsumption architecture

Source ICARCV '92. Second International Conference on Automation, Robotics and Computer Vision; Singapore; 16-18 Sept. 1992;
Sponsored by: IEE; Inst. Meas.& Control; Econom. Development Board; et al;
Singapore; Nanyang Technol. Univ; 3 vol.
(viii+934+viii+861+vii+908) pp.; 1992 pp.; pp. R0-6.5/1-5 vol.3 pp.

Abstract This paper describes the design and construction of an autonomous mobile ROBOT using the subsumption architecture. The long term aim of the project is to build a tour guide that can greet visitors at the entrance and guide them to the appropriate office. Such a ROBOT requires the capability to navigate through a 'natural' environment without colliding with obstacles or humans. Robots with such a capability could have many applications, including law mowing, floor cleaning, inspection, SECURITY patrols and tour guiding. The project is being carried out in two stages. The first is to construct a simple prototype capable of wandering about the environment without any collisions. Stage two of the project is adding navigational capabilities and a voice synthesizer. This paper describes the successful completion of the first stage of the project

Thesaurus mobile robots; navigation; path planning; position control

Other Terms collision avoidance; obstacle avoidance; path planning; navigation; autonomous mobile ROBOT; subsumption architecture ; tour guide

ClassCodes C3390; C1230; C3120C

Article Type Practical; Theoretical / Mathematical

Language English

RecordType Conference

ControlNo. 4575949

AbstractNos. C9402-3390-136

References 6

Country Pub. Singapore

date 1205

Author Arakawa, M.;

Production Eng. Dev. Center, Tokyo Gas Co. Ltd., Japan

Title Development of LNG terminal patrol robots

Source ROBOT;

ROBOT (Japan); no.93; July 1993 pp.; pp. 66-71 pp.

Abstract In Japan, a shortage of manpower has become a serious concern. In gas, electric power and petrochemistry, it is expected that workers will not choose hard, dirty, dangerous work including overnight work in the future. In these industries plant operation has been highly automated; therefore it is necessary to automate the job of patrolling. Patrol robots are under development for a new liquefied natural gas terminal scheduled to start operation in 1997. Various tests using prototype are complete. An explosion-proof ROBOT which will be tested in Sodegaura works is under development. This paper describes the backgrounds, schedule of development, specifications of prototype ROBOT, results of various elements of development, and diagnostic logic for abnormalities

Thesaurus industrial robots; natural gas technology; safety systems; SECURITY

Other Terms patrol robots; liquefied natural gas terminal; explosion-proof ROBOT

ClassCodes C3370L; C3390; C7420; C3310E

Article Type Practical

Coden ROBBDQ

Language Japanese

RecordType Journal

ControlNo. 4549152

AbstractNos. C9401-3370L-004

ISSN 03871940

References 4

Country Pub. Japan

date 1216

Author Orwig, T.;
Cybermotion Inc., Roanoke, VA, USA
Title Cybermotion's roving robots
Source Industrial ROBOT;
Ind. ROBOT (UK); vol.20, no.3; 1993 pp.; pp. 27-9 pp.
Abstract The founders of Cybermotion built and demonstrated a prototype synchronous-drive ROBOT in 1981. That successful 'proof of concept' led to the development of the Navmaster autonomous vehicle, the foundation of Cybermotion ROBOT systems. Since 1990, Cybermotion has focused its developmental efforts on SECURITY applications of the Navmaster. Cybermotion worked closely with the drug company to equip a Navmaster platform with SECURITY instrumentation. The result was the successful SR2 (formerly SPIMASTER), which has proved to be a highly efficient and cost-effective tool for the augmentation of traditional SECURITY operations. The SR2 is a Navmaster equipped with a SECURITY patrol instrumentation (SPI) system which comprises the stator and the scanner, mounted on a vertical boom, and the SPI computer, housed in the ST1, which controls the stator and the scanner over a high-speed synchronous serial I/O link
Thesaurus mobile robots; pharmaceutical industry; safety systems
Other Terms roving robots; Cybermotion; Navmaster; drug company; SR2; SECURITY patrol instrumentation; scanner
ClassCodes C3390; C3350G
Article Type Practical
Coden IDRBAT
Language English
RecordType Journal
ControlNo. 4515756
AbstractNos. C9312-3390-071
ISSN 0143991X
References 0
Country Pub. UK
date 1210

Author Schultz, R.J.; Nakajima, R.; Nomura, J.;
Matsushita Electr. Works Ltd., Osaka, Japan
Title Telepresence mobile ROBOT for SECURITY applications
Source Proceedings IECON '91. 1991 International Conference on Industrial Electrlnics, Control and Instrumentation (Cat. No. 91CH2976-9); Kobe, Japan; 28 Oct.-1 Nov. 1991;
Sponsored by: IEEE; Soc. Instrum. & Control Eng. Japan;
New York, NY, USA; IEEE; 3 vol. 2591 pp.; 1991 pp.; pp. 1063-6 vol.2 pp.
Abstract A mobile telepresence ROBOT is currently being developed for use in surveillance and fire-detection applications that will be integrated into the present intelligent building system. The authors discuss the design, construction, and man-machine interface of the mobile telepresence ROBOT. This system will allow the building operator to patrol remote areas from the safety and comfort of the building's control center. The viewing station contains a BOOM (binocular omni-orientation monitor)-mounted stereoscopic color viewer, while the ROBOT consists of a self-powered mobile platform carrying the slave telepresence camera system and various navigational sensors. The ROBOT patrols a predefined area and goes to a particular landmark autonomously in case of an emergency
Thesaurus computer vision; home automation; mobile robots; safety systems
Other Terms SECURITY system; telepresence mobile ROBOT; surveillance; fire-detection; intelligent building system; man-machine interface; BOOM; binocular omni-orientation monitor; stereoscopic color viewer; navigational sensors
ClassCodes C3390; C3395; C3370L
Article Type Practical
Language English
RecordType Conference
ControlNo. 4280509
AbstractNos. C9212-3390-121
ISBN or SBN 0 87942 688 8
References 9
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Country Pub. USA
date 1193

Author Todd, D.J.;
Dept. of Mech. Eng., Edinburgh Univ., UK
Title Door opening and handle manipulation by automatic guided vehicles
Source 7th International Conference on Computer-Aided Production Engineering; Cookeville, TN, USA; 13-14 Aug. 1991; Amsterdam, Netherlands; Elsevier; xii+593 pp.; 1991 pp.; pp. 373-8 pp.
Editor Venkatesh, V.C.; McGeough, J.A.
Abstract A vehicle, fitted with a simple manipulator, was built which could open a door by grasping and pulling a fixed handle. This paper describes the latest phase of this research, in which the capability of the system is being extended to doors with a handle which must be turned. A new manipulator is being built for the vehicle, with extra joints to allow it to grasp and turn a knob or handle, and also to let the arm be stowed compactly within the vehicle. The design is based on a cylindrical coordinate manipulator with a special wrist and gripper, and builds on previous experience with the control of compliant motion, with motion of both vehicle and arm cooperating to pull the door open. Industrial and other applications are envisaged whenever an automatic guided vehicle or mobile ROBOT must operate in areas which have not been modified or designed for access by unmanned vehicles. These include SECURITY, firefighting and aids for the disabled, as well as many kinds of transport in factories and other buildings
Thesaurus automatic guided vehicles; mobile robots
Other Terms door opening; door handle manipulation; grasping; automatic guided vehicles; knob; cylindrical coordinate manipulator; wrist; gripper; compliant motion; mobile ROBOT; SECURITY; firefighting; disabled; factories
ClassCodes C3390; C3360Z
Article Type Practical
Language English
RecordType Conference
ControlNo. 4194483
AbstractNos. C9208-3390-079
ISBN or SBN 0 444 89214 1
References 3
Country Pub. Netherlands
date 1191

Author White, J.R.; Farnstrom, K.A.; Harvey, H.W.; Upton, R.G.; Walker, K.L.

Title A mobile ROBOT for power plant inspection and maintenance

Source 1988 International Conference on Nuclear Fission: Fifty Years of Progress in Energy SECURITY, and the Topical Meeting TMI-2 Accident: Materials Behaviour and Plant Recovery Technology (papers in summary form only received); Washington, DC, USA; 30 Oct.-4 Nov. 1988;
Transactions of the American Nuclear Society; vol.57; 1988 pp.; pp. 329-30 pp.

Abstract An all-terrain, mobile ROBOT, SURBOT-T, has been developed to perform remote visual, sound, and radiation surveillance within contaminated areas of nuclear power plants. The ROBOT can be equipped with a two-armed, telerobotic manipulator system to perform remote maintenance work. The SURBOT-T vehicle has a double-articulating track base that is capable of climbing 45-deg slopes and stairs and over 16-in.-high obstacles. The overall size of SURBOT-T is 28 in. wide by 38 in. long with the front and rear tracks raised and 52 in. high with the camera lowered. With the tracks in a level position, the base provides a sturdy work platform and can ascend/descend stairs without tipping over. The tracks can be pivoted straight down to elevate the base 14 in. and pass through water up to 24 in. deep. The vehicle can be driven forward or reverse at speeds ranging (continuously variable) from 0 to 24 in./s. Other main design features of SURBOT-T are discussed

Thesaurus fission reactor safety; inspection; maintenance engineering; robots

Other Terms mobile ROBOT; inspection; maintenance; SURBOT-T; 28 in; 52 in; 38 in

ClassCodes A2844; C3390

Article Type Practical

Numerical size 7.1E-01 m; size 1.3E+00 m; size 9.7E-01 m

Coden TANSAO

Language English

RecordType Conference

ControlNo. 3349125

AbstractNos. A89046556; C89025535

ISSN 0003018X

References 0

Country Pub. USA

date 1154

Author Everett, H.R.; Gilbreath, G.A.;
Naval Ocean Syst. Center, San Diego, CA, USA
Title A supervised autonomous SECURITY ROBOT
Source Robotics and Autonomous Systems;
ROBOT. Auton. Syst. (Netherlands); vol.4, no.3; Nov. 1988 pp.;
pp. 209-32 pp.
Abstract ROBART II is a battery powered autonomous ROBOT being used by the Naval Ocean Systems Center in San Diego as a testbed in research which seeks to provide a multi-sensor detection, verification, and intelligent assessment capability for a mobile SECURITY ROBOT. The intent is to produce a robust automated system that exhibits a high probability of detection with the ability to distinguish between actual and nuisance alarms. An architecture of nine distributed microprocessors onboard the ROBOT makes possible advanced control strategies and real-time data acquisition. Higher level tasks (map generation, path planning, position estimation, obstacle avoidance and statistical SECURITY assessment) are addressed by a Planner (currently a remote 80386-based desktop computer). Numerous sensors are incorporated into the system to yield appropriate information for use in position estimation, collision avoidance, navigational planning, and assessing terrain traversibility
Thesaurus artificial intelligence; computerised navigation; microcomputer applications; mobile robots
Other Terms mobile robots; computerised navigation; artificial intelligence; autonomous SECURITY ROBOT; ROBART II; distributed microprocessors; data acquisition; map generation ; path planning; position estimation; obstacle avoidance; statistical SECURITY assessment; Planner; collision avoidance
ClassCodes C3390; C7420
Article Type Practical
Language English
RecordType Journal
ControlNo. 3347332
AbstractNos. C89025516
References 15
Country Pub. Netherlands
date 1155

Author Welch, P.J.;
Syst. & Equipment Eng. Dept., British Nuclear Fuels plc, Warrington, UK

Title Applications of automated sampling systems in British nuclear reprocessing plants

Source Journal of Robotic Systems;
J. ROBOT. Syst. (USA); vol.9, no.2; March 1992 pp.; pp. 187-96 pp.

Abstract Describes the design and development of a fully automated sampling system currently entering service at the British Nuclear Fuels reprocessing complex at Sellafield in the United Kingdom. Novel features of the system are described and the benefits resulting from automation of the sampling system are highlighted

Thesaurus fission reactor fuel preparation and reprocessing; laboratory apparatus and techniques; materials handling; nuclear fuel cycle facilities

Other Terms THORP; liquor DELIVERY system; sampling mechanism; sample transport system; automated sampling systems; nuclear reprocessing plants; British Nuclear Fuels

ClassCodes A2842H; C3380L; C3340F; C3320

Article Type Practical

Coden JRSYDB

Language English

RecordType Journal

ControlNo. 4138884

AbstractNos. A9211-2842H-001; C9206-3380L-004

ISSN 07412223

References 4

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Country Pub. USA

date 1199

Author Ollero, A.; Simon, A.; Garcia, F.; Torres, V.E.;
Dept. de Ingenieria de Sistemas y Autom., Malaga Univ., Spain

Title Integrated mechanical design and modelling of a new mobile ROBOT

Source Intelligent Components and Instruments for Control Applications. Selected Papers from the IFAC Symposium; Malaga, Spain; 20-22 May 1992;
Sponsored by: IFAC;
Oxford, UK; Pergamon Press; xiv+540 pp.; 1993 pp.; pp. 461-6 pp
.

Editor Ollero, A.; Camacho, E.F.

Abstract Presents RAM-1, a new autonomous mobile ROBOT designed as a testbed for the automation of SURVEILLANCE, manipulation and small part transportation. Particularly, the authors describe VAM-1, the robotic vehicle designed for indoor and paved-floor outdoor navigation in unstructured environments. VAM-1 includes several software and hardware components for intelligent navigation. The mechanical design is the result of an integration approach by considering several criteria related with control, planning and perception issues in addition to structural design and other mechanical requirements. The locomotion and control model of VAM-1 is presented. This model involves kinematic and dynamic relations and its parameters have been identified from experimental data

Thesaurus control system synthesis; dynamics; kinematics; mobile robots; navigation; path planning

Other Terms path planning; mechanical design; modelling; mobile ROBOT; RAM-1; VAM-1; intelligent navigation; locomotion; control model; kinematic; dynamic

ClassCodes C3390; C1310; C1230; C3120C

Article Type Practical; Theoretical / Mathematical

Language English

RecordType Conference

ControlNo. 4508666

AbstractNos. C9312-3390-038

ISBN or SBN 0 08 041899 6

References 16

Country Pub. UK

date 1201

Author de Saussure, G.; Weisbin, C.R.; Spelt, P.F.;
Oak Ridge Nat. Lab., TN, USA
Title Navigation and learning experiments by an autonomous ROBOT
Source Robotics and Computer-Integrated Manufacturing;
ROBOT. Comput.-Integr. Manuf. (UK); vol.6, no.4; 1989 pp.; pp.
295-301 pp.
Abstract Developing an autonomous mobile ROBOT capable of navigation, SURVEILLANCE and manipulation in complex and dynamic environments is a key research activity at CESAR, Oak Ridge National Laboratory's Center for Engineering Systems Advanced Research. The latest series of completed experiments was performed using the autonomous mobile ROBOT HERMIES-IIB (Hostile Environment Robotic Machine Intelligence Experiment Series II-B). The paper describes HERMIES-IIB and some of its major components required for autonomous operation in unstructured, dynamic environments. The authors outline some ongoing research in autonomous navigation and discuss their newest research in machine learning concepts. The authors describe a successful experiment in which the ROBOT is placed in an arbitrary initial location without any prior specification of the content of its environment, successively discovers and navigates around stationary or moving obstacles, picks up and moves small obstacles, searches for a control panel and performs a learned sequence of manipulations on the panel devices
Thesaurus computerised navigation; learning systems; mobile robots
Other Terms computerised navigation; autonomous mobile ROBOT; navigation;
SURVEILLANCE; manipulation; HERMIES-IIB; machine learning
ClassCodes C3390; C7420
Article Type Experimental
Coden RCIMEB
Language English
RecordType Journal
ControlNo. 3662533
AbstractNos. C90045540
ISSN 07365845
References 26
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Country Pub. UK
date 1158

Author Kniazewycz, B.G.; Irving, T.L.;
KLM Technol. Inc., Walnut Creek, CA, USA
Title Experience of the Surveyor mobile ROBOT at Nine Mile Point
Source Waste Management '87: Waste Isolation in the U.S., Technical Programs and Public Education. Proceedings of the Symposium; Tucson, AZ, USA; 1-5 March 1987;
Sponsored by: ANS; ASME; EPRI; US Nucl. Regul. Comm.; Univ. Arizona; H18;
La Grange Park, IL, USA; ANS; 3 vol.(xi+700+xi+592+x+823) pp.; 1987 pp.; pp. 97-101 vol.3 pp.
Editor Post, R.G.
Abstract A successful test and evaluation program was recently conducted on a commercial-ready, wireless, remotely operated SURVEILLANCE system for use in nuclear power plants. This evaluation of the Surveyor mobile SURVEILLANCE system took place at Niagara Mohawk Power Corporation's Nine Mile Point (NMP) Nuclear Power Station. The remotely operated vehicle measures radiation, temperature and relative humidity and provides optical inspection capability. The vehicle is readily maneuvered through 36 inch wide passageways and labyrinth entries and can climb stairs, negotiating 180 degree turns on stair landings. The Surveyor system consists of a supervisory control station and a rugged, remotely operated, battery-powered vehicle. The Surveyor system is specifically designed to decrease personnel radiation exposure by supplementing the functions of an auxiliary operator or health physics technician to perform periodic component inspections inside particular areas within a nuclear power plant. The authors describe the recent efforts, achievements and experiences of the personnel at NMP Unit 1. In particular, they discuss the test and evaluation program for the Surveyor mobile SURVEILLANCE ROBOT
Thesaurus fission reactor safety; inspection; nuclear power stations; robots
Other Terms Surveyor mobile ROBOT; remotely operated SURVEILLANCE system; nuclear power plants; Surveyor mobile SURVEILLANCE system; Nine Mile Point; inspection capability; battery-powered vehicle; radiation exposure
ClassCodes A2844; A2850G; B8220; C3390
Article Type Practical; Experimental
Language English
RecordType Conference
ControlNo. 3157769
AbstractNos. A88072716; B88042998; C88034325
References 4
Country Pub. USA
date 1134

Author Yagi, Y.; Kawato, S.
Title Leak detection for plant patrol
Source Journal of the Japan Society of Precision Engineering;
J. Jpn. Soc. Precis. Eng. (Japan); vol.56, no.8; Aug. 1990 pp.;
pp. 1399-402 pp.
Abstract For automation of plant equipment INSPECTION a concentrated INSPECTION system is to be installed at the central supervisory control room to carry out inspections by collecting data from sensors attached to the individual objective equipment. In order to save the number of sensors and inspectors at a large plant, a SENSOR-attached mobile ROBOT for plant patrol is expected to be developed. The sensors need to be small and light, and have the functions of wide-scope monitoring and high-precision detection of abnormal conditions. A laser-applied passive sensing system and image processing algorithm are applicable for detection of leakage of water, oil and steam from piping and valves
Thesaurus automatic optical INSPECTION; computerised picture processing; industrial robots; leak detection; mobile robots
Other Terms lead detection; water leakage; oil leakage; steam leakage; plant patrol; plant equipment INSPECTION; INSPECTION system; central supervisory control room; SENSOR-attached mobile ROBOT; wide-scope monitoring; high-precision detection; laser-applied passive sensing system; image processing algorithm; piping; valves
ClassCodes B0170L; B0170E; C5260B; C3390; C7420; C3355
Article Type Practical
Coden JJPEAD
Language Japanese
RecordType Journal
ControlNo. 3903316
AbstractNos. B91037042; C91041448
ISSN 09120289
References 7
Country Pub. Japan
date 1178

Author Nishi, A.; Miyagi, H.;
Fac. of Eng., Miyazaki Univ., Japan
Title A wall-climbing ROBOT using propulsive force of propeller (mechanism and control system in a strong wind)
Source JSME International Journal, Series C (Dynamics, Control, Robotics, Design and Manufacturing);
JSME Int. J. C, Dyn. Control ROBOT. Des. Manuf. (Japan); vol. 37, no.1; March 1994 pp.; pp. 172-8 pp.
Abstract In the previous report, the mechanism of a wall-INSPECTION ROBOT which is capable of moving in a weak wind on a vertical wall was investigated. For emergency use of a wall-climbing ROBOT, such as in rescue, and fire-fighting, the ROBOT must be able to move in strong and turbulent winds at any time. Therefore, the control system for large wind load is important. A combined control system consisting of a thrust force controller, a frictional force augmentor and a damper is used, and its performance is estimated by a computer simulation technique. The safety of the ROBOT is ascertained for an actual turbulent and strong wind gust
Thesaurus damping; force control; mechatronics; MOBILE robots; position control
Other Terms wall climbing ROBOT; propulsive force; propeller; wall INSPECTION ROBOT; wind load; thrust force controller; frictional force augmentor; damper; safety; control system
ClassCodes C3390; C3120C; C3120F
Article Type Theoretical / Mathematical; Experimental
Coden JCDMEY
Language English
RecordType Journal
ControlNo. 4659164
AbstractNos. C9406-3390-043
ISSN 09148825
References 6
Country Pub. Japan
date 1225

Author Sugiyama, S.; Tanaka, K.; Numata, N.; Nakano, Y.; Fujie, M.; Kamejima, K.; Maki, H.

Title Quadrupedal locomotion subsystem of prototype advanced ROBOT for nuclear power plant facilities

Source 91 ICAR. Fifth International Conference on Advanced Robotics. Robots in Unstructured Environments (Cat. No.91TH0376-4); Pisa, Italy; 19-22 June 1991;
Sponsored by: CNR; CPR; Univ. Genoa; ENEA; IBM SEMEA; Univ. Pisa; IEEE et al;
New York, NY, USA; IEEE; 2 vol. 1827 pp.; 1991 pp.; pp. 326-33 vol.1 pp.

Abstract A prototype advanced ROBOT for remote or automatic maintenance and INSPECTION of nuclear power plant facilities has been developed by the 'Advanced ROBOT Technology' promoted by the Agency of Industrial Science and Technology. This paper deals with the prototype advanced ROBOT and results of the experiments executed in a verification test facility. The ROBOT measures 700 mm*1200 mm*2000 mm and is 750 kg in gross weight, and each leg has four degrees of freedom. Payload up to 250 kg including a double armed manipulator etc. can be mounted on the ROBOT. The loaded ROBOT can move straight, turn, and stride over impediments. If only the starting and stopping points of walking are given by a supervisory controller, it can walk by itself depending on the signals sent from outside image sensors and according to the map information. Various types of walking of the ROBOT have been confirmed by experiments

Thesaurus MOBILE robots; nuclear power stations; nuclear reactor maintenance; position control

Other Terms quadruped locomotion subsystem; prototype advanced ROBOT; nuclear power plant facilities; maintenance; INSPECTION; verification test facility; image sensors; map information; 700 mm; 1200 mm; 1730 to 2000 mm; 750 kg; 250 kg

ClassCodes A2843; B8220; B0160; C3340F; C7420; C7410B; C3390

Article Type Practical; Experimental

Numerical size 7.0E-01 m; size 1.2E+00 m; size 1.73E+00 to 2.0E+00 m; mass 7.5E+02 kg; mass 2.5E+02 kg

Language English

RecordType Conference

ControlNo. 4459156

AbstractNos. A9318-2843-008; B9309-8220-020; C9309-3340F-002

ISBN or SBN 0 7803 0078 5

References 5

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7803-0078/91/0600-0326$01.00

Country Pub. USA

date 1189

Author Byung Soo Kim; Chang Hoi Kim; Suk Young Hwang; Seung Ho Kim; Jong Min Lee;
Korea Atomic Energy Res. Inst., Seoul, South Korea

Title The study on the stair-climbing algorithm of a MOBILE ROBOT in nuclear facilities

Source Journal of the Korean Institute of Telematics and Electronics; J. Korean Inst. Telemat. Electron. (South Korea); vol.29B, no.6 ; June 1992 pp.; pp. 17-24 pp.

Abstract A MOBILE ROBOT should be able to climb up and down stairs with stability for INSPECTION and maintenance in nuclear facilities. This paper presents a stair-climbing algorithm for a planetary wheel type ROBOT that is able to go up and down irregular stairs automatically with stable posture. The proposed algorithm is composed of two parts; one is to generate the moving path to give a guarantee for the stable contact-posture between six small wheels and the surface of the stairs, and the other is to calculate the angular velocity of each wheel to follow the generated path. Simulations and experiments on the irregular stairs are carried out on the MOBILE ROBOT, KAEROT. The proposed algorithm proved to be very effective. The inclination angle of KAEROT is maintained below 30.8 degrees while it is climbing up stairs with a slope of 25 degrees

Thesaurus MOBILE robots; nuclear power stations; path planning; power station computer control

Other Terms stair-climbing algorithm; MOBILE ROBOT; nuclear facilities; INSPECTION; maintenance; planetary wheel type ROBOT; moving path; angular velocity; KAEROT; inclination angle

ClassCodes C3340F; C3390; C7420; C7470

Article Type Practical

Coden CKNOEZ

Language Korean

RecordType Journal

ControlNo. 4308000

AbstractNos. C9302-3340F-002

ISSN 1016135X

References 12

Country Pub. South Korea

date 1202

Author Nishi, A.;

Dept. of Appl. Phys., Miyazaki Univ., Japan

Title A biped walking ROBOT capable of moving on a vertical wall

Source Mechatronics;

Mechatronics (UK); vol.2, no.6; Dec. 1992 pp.; pp. 543-54 pp.

Abstract The use of a wall-climbing ROBOT for purposes such as rescue, wall INSPECTION and fire-fighting on high-rise buildings has been anticipated for a long time. Three different types of wall-climbing robots have been developed in Japan. The first one has a large area sucker, which has the reverse mechanism of a hovercraft. This type can be used only on flat and wide surfaces. The second one has crawlers to move on a vertical wall with many small suckers on them. The third one has a walking mechanism with small suckers on each foot. A biped walking model was built and tested on a vertical wall and a ceiling. The aerodynamic matching between blower performance and required forces of a sucker, as well as the control systems of the ROBOT, are studied in detail

Thesaurus MOBILE robots; position control

Other Terms biped walking ROBOT; vertical wall; high-rise buildings; sucker; crawlers; biped walking model; aerodynamic matching; control systems

ClassCodes C3390; C3120C; C7420

Article Type Practical

Coden MECHER

Language English

RecordType Journal

ControlNo. 4273540

AbstractNos. C9212-3390-064

ISSN 09574158

References 5

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Country Pub. UK

date 1208

Author Guzowski, S.;
Odetics, Anaheim, CA, USA
Title Odex III: building on the EPRI walking ROBOT
Source Nuclear Engineering International;
Nucl. Eng. Int. (UK); vol.36, no.449; Dec. 1991 pp.; pp. 40, 42
pp.
Abstract Odetics has delivered a second generation preproduction Odex III ROBOT to the French CEA. The CEA is currently using the system in the SHERPA project, part of the EC's Teleman programme. The ROBOT features improved leg design and power electronic systems derived from the original Odex III walking ROBOT, developed in partnership with EPRI. The new work packages developed at the CEA will be instrumental in evolving Odex III from a transport platform to an application-specific system
Thesaurus fission reactor safety; INSPECTION; MOBILE robots
Other Terms Odex III ROBOT; SHERPA project; walking ROBOT
ClassCodes A2844; C3390
Article Type Practical
Coden NEINBF
Language English
RecordType Journal
ControlNo. 4070757
AbstractNos. A9204-2844-086; C9202-3390-277
ISSN 00295507
References 0
Country Pub. UK
date 1195

Author Billingsley, J.; Collie, A.A.; Luk, B.L.;
Portsmouth Polytech., UK

Title A climbing ROBOT with minimal structure

Source International Conference on Control '91 (Conf. Publ. No.332); Edinburgh, UK; 25-28 March 1991; London, UK; IEE; 2 vol. xxvi+1282 pp.; 1991 pp.; pp. 813-15 vol.2 pp.

Abstract The wall-climbing ROBOT 'Zigzag' is one of a succession of MOBILE robots devised at Portsmouth Polytechnic. Zigzag has but one degree of freedom and strictly has no legs at all. It is controlled at present by direct command from a desk-top computer; when microcontrollers are introduced, each processor will control an entire Zigzag and a supervising microcomputer will direct a team of these robots. The very simplicity of the machine should speed its application and exploitation for tasks including painting, INSPECTION and maintenance of vertical or sloping surfaces

Thesaurus computerised control; MOBILE robots

Other Terms MOBILE robots; climbing ROBOT; Portsmouth Polytechnic; Zigzag; microcontrollers

ClassCodes C3390; C7420

Article Type Experimental

Language English

RecordType Conference

ControlNo. 3944724

AbstractNos. C91052018

ISBN or SBN 0 85296 509 5

References 2

Country Pub. UK

date 1186

Author Collie, A.A.; Billingsley, J.; Von Puttkamer, E.;
Dept. of Syst. Eng., Portsmouth Polytech., UK
Title Design and performance of the Portsmouth climbing ROBOT
Source Mechatronic Systems Engineering;
Mechatronic Syst. Eng. (USA); vol.1, no.2; 1990 pp.; pp. 125-30 pp.
Abstract The Portsmouth climbing ROBOT, Robug II is a prototype research vehicle designed to demonstrate the feasibility of an articulated-limb climbing machine. Its architecture mirrors the structure of an insect. A central body which will support INSPECTION or other equipment is carried to the required location by four (or more) fully articulated legs. These are mounted at the corners of the body and suspend it clear of the surface. Each leg has a suction cup foot powered by an ejector vacuum pump. Additional suction feet are fitted to the body so that it may be locked in place while INSPECTION is taking place, or between paces where the terrain is difficult. Intelligence is distributed, each leg being provided with individual microprocessor control. Foothold is tested before weight is transferred. The legs are able to step over obstructions and negotiate changes in level
Thesaurus computerised control; control system synthesis; microcomputer applications; MOBILE robots
Other Terms MOBILE robots; design; walking machines; Portsmouth climbing ROBOT; Robug II; articulated-limb climbing machine; ejector vacuum pump; microprocessor control
ClassCodes C3390; C7420
Article Type Practical
Language English
RecordType Journal
ControlNo. 3840629
AbstractNos. C91021408
ISSN 09243992
References 2
Country Pub. USA
date 1171

Author Hirose, S.; Morishima, A.;
Dept. of Mech. Eng. Sci., Tokyo Inst. of Technol., Japan
Title Design and control of a MOBILE ROBOT with an articulated body
Source International Journal of Robotics Research;
Int. J. ROBOT. Res. (USA); vol.9, no.2; April 1990 pp.; pp. 99-114 pp.
Abstract MOBILE robots having good terrain adaptability, sufficient payload capability, and high mobility are now urgently in demand. In the paper, design of a practical MOBILE ROBOT is attempted, with an INSPECTION task in a nuclear reactor as an objective for development. The configuration of the MOBILE ROBOT is first discussed. A wheel with crawler track, legs, and a snake-like articulated body are shown to be three fundamental configurations. A hybrid configuration consisting of an articulated body and a crawler track is most adequate for the nuclear reactor ROBOT because of its excellent terrain adaptability, sufficient payload capability, and high mobility. Design of the joint structure of the articulated body is discussed. Basic control problems such as signal processing for tactile sensors and control of statically indeterminant forces are also investigated. A mechanical model KRI, a ROBOT with six articulated body segments, 16 degrees of freedom, length 1391 mm, and weight 27.8 kg, is constructed and several experiments are done to demonstrate the basic mobility of the ROBOT and to show the validity of introducing force control
Thesaurus fission reactor safety; INSPECTION; MOBILE robots
Other Terms KRI mechanical model; MOBILE ROBOT; articulated body; terrain adaptability; INSPECTION; nuclear reactor; signal processing; tactile sensors; statically indeterminant forces; force control
ClassCodes A2844; C3340F; C3390
Article Type Applications
Coden IJRREL
Language English
RecordType Journal
ControlNo. 3640746
AbstractNos. A90079699; C90039105
ISSN 02783649
References 25
Country Pub. USA
date 1174

Author Dillman, R.;
Karlsruhe Univ., West Germany
Title MOBILE robots in industrial environments
Source Proceedings of the 18th International Symposium on Industrial Robots; Lausanne, Switzerland; 26-28 April 1988; A09; Kempston, Bedford, UK; IFS Publications; x+515 pp.; April 1988 pp.; pp. 79-89 pp.
Editor Burckhardt, C.W.
Abstract A family of MOBILE robots is presented, which is to be developed for application in industrial environments. The MOBILE ROBOT units can be used as autonomous transport vehicles, as autonomous MOBILE robots equipped with ROBOT arms for INSPECTION, assembling or spray painting. Other applications are general purpose transport and carrier tasks for support of material flows with CIM systems. Special purpose applications like fire fighting, handling under radioactive emission or chemical environment are possible. Based on the experimental Karlsruhe autonomous MOBILE ROBOT (KAMRO) three types of computer piloted vehicles (CPV) are under development. The CPV1 is a basic prototype controlled with dead reckoning control principle. CPV2 is an integrated system with an independent navigation and a fine positioning system, capable of controlling the travelling path with respect to position and orientation. CPV3 is a system which is supervised by a central computer which distributes orders and mission descriptions to each individual vehicle. The hardware and software architecture of the KAMRO system and the MOBILE ROBOT family is presented and the state of implementation and results are discussed. Methodologies for planning and integration of the MOBILE robots into a CIM oriented manufacturing environment are outlined
Thesaurus industrial robots; position control
Other Terms industrial robots; position control; MOBILE robots; autonomous transport vehicles; ROBOT arms; INSPECTION; assembling; spray painting; transport; carrier tasks; material flows; CIM systems; fire fighting; radioactive emission; chemical environment; Karlsruhe autonomous MOBILE ROBOT; computer piloted vehicles; CPV1; dead reckoning control principle; CPV2; navigation; fine positioning system ; CPV3; central computer; KAMRO system
ClassCodes C3120C; C3355; C3390
Article Type Applications
Language English
RecordType Conference
ControlNo. 3208103
AbstractNos. C88050604
ISBN or SBN 0 948507 97 7
References 16
Country Pub. UK
date 1148

Author Littmann, F.; Villedieu, E.; Chameaud, H.;
CEA, CEN, Fontenay aux Roses, France

Title A trainlike vehicle for intervention missions inside nuclear plants

Source 1992 Winter Meeting. International Conference on Fifty Years of Controlled Nuclear Chain Reaction: Past, Present and Future (Papers in summary form only received); Chicago, IL, USA; 15-20 Nov. 1992;
Sponsored by: ANS;
Transactions of the American Nuclear Society; vol.66; 1992 pp.; pp. 551 pp.

Abstract The Unite Robotique (part of the Direction of Advanced Technologies of Commissariat a l'Energie Atomique) has worked on nuclear robotics in the field of master/slave manipulators with their associated computer-aided teleoperation controls and mobile robots. The CENTAURE mobile ROBOT is tracked (for stair climbing) and articulated (for obstacle crossing and turning on stair landings) with a mobile platform (for increasing stability), designed for INSPECTION missions. For intervention missions, one needs a vehicle with larger payload capabilities (volume and mass) but with the same geometrical and ENVIRONMENTAL constraints

Thesaurus mobile robots; nuclear reactor maintenance; radioactivity measurement

Other Terms nuclear robotics; master/slave manipulators; computer-aided teleoperation; mobile robots; CENTAURE; mobile ROBOT; stair climbing; articulated; obstacle crossing; INSPECTION missions

ClassCodes A2843; A2890; A2880; C3340F; C3390; C7470; C7420

Article Type Practical

Coden TANSAO

Language English

RecordType Conference

ControlNo. 4341013

AbstractNos. A9306-2843-005; C9303-3340F-010

ISSN 0003018X

References 0

Country Pub. USA

date 1207

Author Hayasaka, Y.
Title R&D of advanced ROBOT for nuclear power plant facilities
Source ROBOT;
ROBOT (Japan); no.62; May 1988 pp.; pp. 44-51 pp.

Abstract A nuclear power ROBOT is being developed to relieve human operators from the equipment checking and testing job in a high radiation dosage environment during normal run operation of the nuclear power plant. In ENVIRONMENTAL conditions involving a dosage of 150 R/hr, 70 degrees C in temperature, and 100% RH in humidity (conditions that simulate the environment in a nuclear reactor containment vessel during reactor operation) the ROBOT should be able to arrive at a job site by walking over uneven floors, climbing up and down stairs, passing over or under an obstacle as required, making turns at right angles, and so on, and should be able to inspect, repair, or otherwise handle valves, pumps, heat-exchangers, and other equipment or instruments in the power station. For the development of this ROBOT, following elementary technologies are being researched and developed: locomotion mechanism, manipulator, information processing and transmission, reliability, and radiation hardness

Thesaurus fission reactor safety; INSPECTION; nuclear power stations; robots
Other Terms INSPECTION; repairing; advanced ROBOT; nuclear power plant; nuclear reactor containment vessel; locomotion mechanism; manipulator; information processing; reliability; radiation hardness
ClassCodes A2844; B8220; C3340F; C3390
Article Type Practical
Coden ROBBDQ
Language Japanese
RecordType Journal
ControlNo. 3269549
AbstractNos. A89000625; B89006785; C89001128
ISSN 03871940
References 2
Country Pub. Japan
date 1149

Author Smith, D.J.

Title Robots reduce radiation exposure in nuclear MAINTENANCE

Source Power Engineering;
Power Eng. (USA); vol.93, no.7; July 1989 pp.; pp. 22-8 pp.

Abstract The nuclear industry is developing and utilizing robots to carry out more and more of the routine work of nuclear power station INSPECTION, decontamination and MAINTENANCE. CECIL (Consolidated Edison Combined INSPECTION and Lancing system) is a ROBOT equipped with an electronic eye and water jets, it is capable of inspecting and cleaning areas previously inaccessible. A reactor weld repair system has also been developed, it is carried into the reactor by a remotely controlled ROBOT. These and other remote handling robots are described for MAINTENANCE in nuclear power stations

Thesaurus INSPECTION; MAINTENANCE engineering; mobile robots; nuclear power stations; telecontrol

Other Terms nuclear power stations; INSPECTION; decontamination; MAINTENANCE; CECIL; Consolidated Edison Combined INSPECTION and Lancing system; reactor weld repair system; remotely controlled ROBOT

ClassCodes B8220; B0160; B0170L; C3340F; C3390; C7420; C3250

Article Type Practical

Coden POENAI

Language English

RecordType Journal

ControlNo. 3493041

AbstractNos. B89073639; C89065760

ISSN 00325961

References 0

Country Pub. USA

date 1164

Author Kniazewycz, B.G.; Darvish, A.R.; Irving, T.L.;
KLM Technol. Inc., Walnut Creek, CA, USA

Title Experience with the Surveyor mobile ROBOT in radioactive work environments

Source 1986 Winter Meeting of the American Nuclear Society; Washington, DC, USA; 16-20 Nov. 1986;
Transactions of the American Nuclear Society; vol.53; L13; 1986 pp.; pp. 497-8 pp.

Abstract Summarizes the development and implementation history of the Surveyor mobile robotic device from November 1985 through August 1986. This two-tracked remotely controlled tetherless device is used to conduct surveillance and INSPECTION and light MAINTENANCE missions in nuclear power plants. Surveyor's relatively light weight (<400 lb) can easily be transported manually from location to location. The total maximum payload of the device, which is able to climb 40-deg stairs, is up to 300 lb when transported on a level floor. Surveyor can traverse through 14 in. of water and over 9-in.-high obstacles

Thesaurus MAINTENANCE engineering; nuclear power stations; robots

Other Terms Surveyor mobile robotic device; two-tracked remotely controlled tetherless device; surveillance; INSPECTION; light MAINTENANCE missions; nuclear power plants

ClassCodes B0160; B8220; C3340F; C3390

Article Type Practical

Coden TANSAO

Language English

RecordType Conference

ControlNo. 2866096

AbstractNos. B87030319; C87021672

ISSN 0003018X

Country Pub. USA

date 1129

Author Krishnamurthy, B.; Evans, J.;
Transitions Res. Corp., Danbury, CT, USA
Title HelpMate: A robotic courier for hospital use
Source 1992 IEEE International Conference on Systems, Man and Cybernetics (Cat. No.92CH3176-5); Chicago, IL, USA; 18-21 Oct. 1992;
Sponsored by: IEEE;
New York, NY, USA; IEEE; 2 vol. xviii+1735 pp.; 1992 pp.; pp. 1630-4 vol.2 pp.
Abstract HelpMate has been designed to perform fetch and carry tasks while exhibiting humanlike behavior as it navigates down crowded hallways in the hospital. The tasks typically performed by the ROBOT are carrying late meal trays, sterile supplies, medications, medical records, reports, samples, specimens, and mail. HelpMate is able to traverse the main arteries of hospitals, crossing between the buildings using interconnected corridors and elevators. Odometry-based navigation is enhanced by sonar, infrared, and vision sensors which aid in obstacle DETECTION and avoidance maneuvers. A map of the hospital is made available to HelpMate, from which it is able to generate a path from any location in the hospital to any destination. An extremely simple human interface has been specially designed for this application. The onboard screen, emergency stops, warning lights, turn signals, and pause buttons provide easy and quick interaction with the system
Thesaurus health care; MOBILE robots
Other Terms odometry-based navigation; HelpMate; robotic courier; hospital; fetch and carry tasks; humanlike behavior; meal trays; sterile supplies; medications; medical records; reports; samples; specimens; mail; human interface
ClassCodes C3390; C3320
Article Type Practical
Language English
RecordType Conference
ControlNo. 4601902
AbstractNos. C9403-3390-146
ISBN or SBN 0 7803 0720 8
References 4
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Country Pub. USA
date 1206

Author Tanaka, Y.; Matoba, Y.;
Dept. of Mech. Eng., Okayama Univ., Japan
Title Study of an intelligent hexapod walking ROBOT
Source Proceedings IROS '91. IEEE/RSJ International Workshop on Intelligent Robots and Systems '91. Intelligence for Mechanical Systems (Cat. No.91TH0375-6); Osaka, Japan; 3-5 Nov. 1991;
Sponsored by: IEEE; RSJ; SICE; New Technol. Found.; JSME; et al;
New York, NY, USA; IEEE; 3 vol. xxxiv+1674 pp.; 1991 pp.; pp. 1535-40 vol.3 pp.
Abstract Concerns a hexapod walking ROBOT designed for use in living and working spaces where it is necessary to ascend and descend structures such as stairs. It is designed to carry loads while always maintaining horizontal balance. It has eight CPUs for controlling the movement of twenty driving motors and for detecting attitude and its environment. It can move around autonomously as well as according to the operator's commands. The ROBOT's configuration, structure and mechanism, and intelligence, are discussed
Thesaurus attitude control; MOBILE robots; position control
Other Terms living spaces; domestic ROBOT; attitude DETECTION; environment DETECTION; ROBOT configuration; ROBOT structure; ROBOT mechanism; intelligent hexapod walking ROBOT; working spaces; stairs; horizontal balance
ClassCodes C3390; C3120C
Article Type Practical
Language English
RecordType Conference
ControlNo. 4209119
AbstractNos. C9209-3390-200
ISBN or SBN 0 7803 0067 X
References 10
Country Pub. USA
date 1194

Author Fogle, R.F.; Heckendorn, F.M.;
Westinghouse Savannah River Co., Aiken, SC, USA

Title Teleoperated equipment for emergency response applications at the Savannah River Site

Source Journal of Robotic Systems;
J. ROBOT. Syst. (USA); vol.9, no.2; March 1992 pp.; pp. 169-85 pp.

Abstract The Robotics Development Group (RDG) of the Westinghouse Savannah River Company (WSRC) is developing an array of teleoperated vehicles and support equipment to be used in emergency response applications. Teleoperators have been used to monitor and map radiation areas, perform decontamination tasks, and handle radioactive material. Other possible scenarios include video surveillance, remote sensing, and fire fighting. The primary justification for developing teleoperated vehicles and support hardware is to eliminate or significantly reduce personnel exposure to radioactive or other hazardous activities. This paper discusses past, present, and future applications that use teleoperated equipment and current development work on several MOBILE teleoperators at the US Department of Energy's (DoE) Savannah River Site (SRS)

Thesaurus monitoring; nuclear fuel cycle facilities; pollution DETECTION and control; radioactive pollution; radioactivity measurement; robots; telecontrol equipment

Other Terms radiation areas mapping; monitoring; radioactive materials handling; telecontrol equipment; emergency response; Savannah River Site; teleoperated vehicles; decontamination; video surveillance; remote sensing; fire fighting

ClassCodes A2846; A2880F; A2842H; A8670L; C3340F; C3390; C3250
Article Type Practical
Coden JRSYDB
Language English
RecordType Journal
ControlNo. 4138883
AbstractNos. A9211-2846-001; C9206-3340F-003
ISSN 07412223
References 6
U.S. Copyright Clearance Center Code
0741-2223/92/020169-17$04.00
Country Pub. USA
date 1199

Author Sagisawa, S.;
Adv. ROBOT Technol. Res. Assoc., Tokyo, Japan
Title Advanced ROBOT for HAZARDOUS environment an outline of Japanese national R&D project 'Advanced ROBOT Technology'
Source 91 ICAR. Fifth International Conference on Advanced Robotics. Robots in Unstructured Environments (Cat. No.91TH0376-4); Pisa, Italy; 19-22 June 1991;
Sponsored by: CNR; CPR; Univ. Genoa; ENEA; IBM SEMEA; Univ. Pisa; IEEE et al;
New York, NY, USA; IEEE; 2 vol. 1827 pp.; 1991 pp.; pp. 315-19 vol.1 pp.
Abstract A Japanese National Research and Development Project aimed at realization of next generation robots and cultivation of elementary technology for advanced robots was finished successfully in 1990. An outline of the project is given, and three robots are presented. One is for maintenance, inspection and repair in nuclear power plants; one is for similar functions in offshore oil facilities; and one is for fire-fighting, fire prevention and rescue in petrochemical facilities. All are supported by a remote operator
Thesaurus disasters; fires; inspection; maintenance engineering; MOBILE robots; nuclear power stations; oil technology; petroleum industry; telecontrol
Other Terms telecontrol; HAZARDOUS environment; Japanese national R&D project; advanced robots; maintenance; inspection; repair; nuclear power plants; offshore oil facilities; fire-fighting ; fire prevention; rescue; petrochemical facilities; remote operator
ClassCodes B8220; B0160; C3390; C3250; C7420; C3340F; C3310E; C3350G
Article Type Practical
Language English
RecordType Conference
ControlNo. 4459154
AbstractNos. B9309-8220-019; C9309-3390-084
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References 1
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date 1189

Author Golden, J.A.; Zheng, Y.F.;
Dept. of Electr. & Comput. Eng., Clemson Univ., SC, USA

Title Gait synthesis for the SD-2 biped ROBOT to climb stairs

Source International Journal of Robotics & Automation;
Int. J. ROBOT. Autom. (USA); vol.5, no.4; 1990 pp.; pp. 149-59 pp.

Abstract The need for machines that can replace humans in HAZARDOUS or tedious occupations has been demonstrated time and again. Since most work places have been designed for human workers, any machine which is to perform the same tasks as humans must have the same mobility. One of the most common obstacles to overcome is the stairwell. The article examines the method by which humans climb stairs, and concludes that human beings use static gaits for stair climbing. By theoretical analysis, it is further revealed that dynamic gaits are not energy efficient for stair climbing. Based on the observation and analysis of the gait employed by human beings, a stair-climbing gait for the SD-2 biped ROBOT is synthesized. The results of experimentation with the ROBOT, which culminated in the ability to climb stairs, are presented, the most important being that the SD-2 is the first biped ROBOT to have this ability

Thesaurus MOBILE robots

Other Terms gait synthesis; SD-2 biped ROBOT; mobility; stairwell; static gaits; dynamic gaits; stair-climbing gait

ClassCodes C3390

Article Type Practical

Coden IJAUED

Language English

RecordType Journal

ControlNo. 3922290

AbstractNos. C91046338

ISSN 08268185

References 22

Country Pub. USA

date 1171

Author Weisbin, C.R.; Montemerlo, M.; Whittaker, W.;
Jet Propulsion Lab., California Inst. of Technol. Pasadena, CA, USA
Title Evolving directions in NASA's planetary rover requirements and technology
Source Robotics and Autonomous Systems;
ROBOT. Auton. Syst. (Netherlands); vol.11, no.1; May 1993 pp.; pp. 3-11 pp.
Abstract This paper reviews the evolution of NASA's planning for planetary rovers (i.e. robotic vehicles which may be deployed on planetary bodies for exploration, science analysis, and CONSTRUCTION) and some of the technology that has been developed to achieve the desired capabilities. The program is comprised of a variety of vehicle sizes and types in order to accommodate a range of potential user needs. This includes vehicles whose weight spans a few kilograms to several thousand kilograms; whose locomotion is implemented using wheels, tracks, and legs; and whose payloads vary from microinstruments to large scale assemblies for CONSTRUCTION. The authors first describe robotic vehicles, and their associated control systems, developed by NASA in the late 1980s as part of a proposed Mars Rover Sample Return (MRSR) mission. Suggested goals at that time for such an MRSR mission included navigating for one to two years across hundreds of kilometers of Martian surface; traversing a diversity of rugged unknown terrain, collecting and analyzing a variety of samples; and bringing back selected samples to the lander for return to Earth. Subsequently, the authors present the current plans (considerably more modest) which have evolved both from technological 'lessons learned' in the previous period, and modified aspirations of NASA missions. This paper describes some of the demonstrated capabilities of the developed machines and the technologies which made these capabilities possible
Thesaurus Mars; MOBILE robots; reviews; space research; space vehicles
Other Terms Robby; Ambler; Rocky-4; Go-For; planetary rover; robotic vehicles; Mars Rover Sample Return; MRSR mission; rugged unknown terrain; NASA
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References 11

Country Pub. Netherlands
date 1214

Author Nair, S.S.;
Dept. of Mech. & Aerosp. Eng., Missouri Univ., Columbia, MO, USA

Title Overview of the features of a legged locomotion system for unstructured environments

Source Automation in CONSTRUCTION;
Autom. Constr. (Netherlands); vol.1, no.4; March 1993 pp.; pp. 361-70 pp.

Abstract A review is given of the important features of a six legged walking ROBOT relevant to an unstructured automation environment. The ROBOT, Adaptive Suspension Vehicle, was developed at the Ohio State University by K.J. Waldron and R.B. McGhee (1986), and is currently undergoing field testing. Several design issues including mechanical structure, mobility and gait characteristics, and computer systems are briefly mentioned. Subsequently the power and the leg actuation and control system features are considered in more detail. The Adaptive Suspension Vehicle is one of the most sophisticated of its kind, at present, and breaks new ground by demonstrating the feasibility of walking routinely on uneven terrain in an efficient manner

Thesaurus mechanical engineering computing; MOBILE robots
Other Terms legged locomotion system; six legged walking ROBOT; unstructured automation environment; Adaptive Suspension Vehicle; field testing; design issues; mechanical structure; mobility; gait characteristics; computer systems; leg actuation; control system features; uneven terrain
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Language English
RecordType Journal
ControlNo. 4406706
AbstractNos. C9306-7420-046
ISSN 09265805
References 24
Country Pub. Netherlands
date 1212

Author Luk, B.L.; Collie, A.A.; Billingsley, J.;
Portsmouth Polytech., UK
Title Robug II: An intelligent wall climbing ROBOT
Source Proceedings. 1991 IEEE International Conference on Robotics and Automation (Cat. No.91CH2969-4); Sacramento, CA, USA; 9-11 April 1991;
Sponsored by: IEEE;
Los Alamitos, CA, USA; IEEE Comput. Soc. Press; 3 vol.
xxxix+2843 pp.; 1991 pp.; pp. 2342-7 vol.3 pp.
Abstract An intelligent wall-climbing ROBOT is described. Its pneumatic drive system gives good power-to-weight ratio while the CONSTRUCTION is based on versatile modules. With a hierarchical distributed computer controller, the system can readily be reconfigured for specific tasks. Details of the CONSTRUCTION and the locomotion algorithms are given
Thesaurus artificial intelligence; computerised control; distributed control; MOBILE robots; pneumatic control equipment
Other Terms MOBILE robots; Robug II; intelligent wall climbing ROBOT; pneumatic drive system; power-to-weight ratio; hierarchical distributed computer controller; locomotion algorithms
ClassCodes C3390; C7420; C1230
Article Type Practical
Language English
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AbstractNos. C9204-3390-237
ISBN or SBN 0 8186 2163 X
References 3
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Country Pub. USA
date 1187

Author Glaskin, Max
Title Robot jobsworths go on patrol
Source New Scientist, v141n1910, 19, Jan 29, 1994,
Abstract Oxford researchers have developed ROBOTS that could replace SECURITY guards. The Oxford robot is the first that can reliably map a changing environment and plan its own route.
Subjects ROBOTS; Research & development; R&D; SECURITY personnel
Company Name Oxford University
ISSN 0262-4079
Article Type News
Length Short (1-9 col inches)
Availability UMIACH1249.02
ARN
ARN

Author Anonymous
Title Unmanned police vehicle
Source Electronics Now, v64n4, 4, Apr 1993,
Features Photograph
Abstract Police in Huntsville AL are testing an unmanned ground vehicle, called the HAZARD Avoidance Reconnaissance Extender, or HARE. The vehicle can enter hazardous situations without endangering human lives.
Subjects Vehicles; ROBOTS; Police
Company Name Police Department-Huntsville AL
ISSN 0033-7862
Article Type News
Length Short (1-9 col inches)
Availability UMIACH204.01
ARN G-GRAD-65-3
ARN G-GRAD-65-3

Author Anonymous
Title Real robocop captures murder suspect
Source Current Science, v79n10, 15, Jan 14, 1994,
Features Photograph
Abstract A mechanical robocop was recently used to help police in Maryland capture a murder suspect. The robot, called an RMI, normally defuses bombs or removes HAZARDOUS chemicals.
Subjects ROBOTS; Law enforcement; Murders & murder attempts
ISSN 0011-3905
Place Names Maryland
Article Type News
Length Short (1-9 col inches)
Availability UMIACH1852.00
ARN
ARN

Author Normile, Dennis
Title Robotics: Viewing volcanoes from a safe perch
Source Popular Science, v242n6, 45, Jun 1993,
Features Illustration
Abstract Engineers at Japan's NHK public broadcasting system have developed a robotic mini-helicopter that is meant to fly over HAZARDOUS or inaccessible sites.
Subjects Helicopters; ROBOTS
ISSN 0161-7370
Article Type News
Length Short (1-9 col inches)
Availability UMIACH141.00
ARN G-GPOS-67-18
ARN G-GPOS-67-18

Author Anderson, Mary Rose
Title Ecological ROBOTS
Source Technology Review, v95n1, 22-23, Jan 1992,
Features Photograph
Abstract Researchers at the DOE are increasingly thinking that ROBOTS could take over ecological cleanups too dangerous or expensive for humans. The assignments range from removing leaky drums of toxic materials from contaminated sites to long-term monitoring of polluted facilities.
Subjects ROBOTS; Research & development; R&D; HAZARDOUS & toxic materials; Environmental cleanup; Technology
ISSN 0040-1692
Article Type News
Length Medium (10-30 col inches)
Availability UMIACH6592.00
ARN G-TCR-34-13
ARN G-TCR-34-13

Author Quinn, James
Title ROBOT Cop
Source Los Angeles Times, Aug 22, 1990, B, 1:2,
Features Photograph
Abstract Andros, the new ROBOT unveiled by the Los Angeles County Sheriff's Department, can be used to shoot guns, open doors, CLIMB stairs, ford a shallow stream, and disarm bombs.
Subjects Robots; Police; Law enforcement
ISSN 0458-3035
Place Names Los Angeles California
Article Type News
Length Long (18+ col inches)